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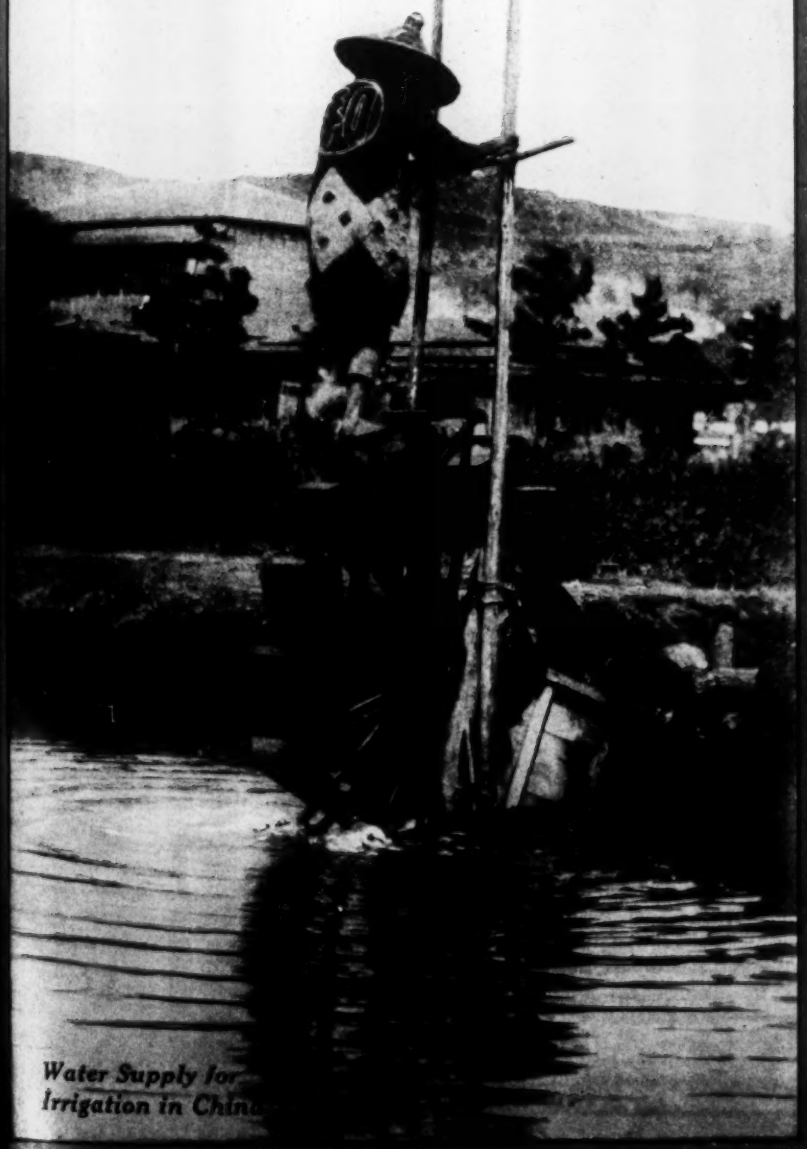

Water Supply for Irrigation in China

Water-Works Number

The Size of Distributing Reservoirs
By Allen Hazen

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Water Supply Problems and Projects in California
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September 2, 1920

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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The Coming Water-Works Convention

ALONG and varied program has been provided for the annual convention of the New England Water Works Association at Holyoke, Mass., next week. In recognition of the meeting much of our space this week is given to water-works and allied subjects.

Adventures in New Fields

THE symposium on the shrinkage of filter sands, the studies of the Venturi flume, the examination of water consumption in three wholly metered cities in relation to the size of distributing reservoirs, each the subject of an article in this issue, exhibit the engineer as an eager adventurer in new fields.

Man Power for Pumping

PRIMITIVE methods of lifting water still prevail in the Far East, as may be seen from the view on our front cover and the notes from a much-travelled engineer on p. 448. In many other respects Asia and Africa are still dependent on man power. Slowly but surely this is bound to change. The resulting effect on the machinery markets of the world, as well as upon the lives and comfort and uplift of vast populations, will be of great significance.

Pumping Station Economies

FROM the crude man-driven water lifts of industrially stagnant Korean countrymen to the triple expansion pumping engines and steam-turbine-driven pumps of an up-to-date water-works plant is a long leap. It suggests an essay or a book. Neither can be attempted here, but the opportunity may be seized to call attention to the remarkable essay written some years ago by one of our foremost engineers, the late George S. Morison, "The New Epoch as Developed by the Manufacture of Power." Coming back to the practical questions of the present time: The successful efforts to get higher efficiencies from the boilers and pumps at St. Louis, recounted in the abstract of Mr. Day's paper on p. 441, should and doubtless will stimulate other water-works men to work for increased efficiency in the application of manufactured power.

Railway Water Supplies

DESIGN and operating conditions of railway water stations and pumping plants differ from those of municipal plants in that there is much less definite organization and centralizing of responsibility. Besides this, instead of one unit system under the continual supervision of an engineer or superintendent who gives it all his attention, there are numerous scattered and relatively small plants which are in local charge of foremen who have many other matters under their care. Similarly, the water systems on a railway or a division are only items in the work of the assistant engineer who has more or less responsibility for the water-supply plants in addition to bridges, bulidings, track maintenance and other lines of railway work and equipment. For these reasons, the railway engineers and foremen are likely to be less well informed on water-supply matters than are the men in charge of municipal water-works. These conditions were suggested in *Engineering News-Record*, June 17, 1920, pp. 1181 and 1202, and are again brought to the front by the article on p. 463 of this issue.

Epidemics and the Engineer

CHOLERA has almost disappeared from countries that function ably in a health-protective way and typhoid is following rapidly after, although still far too much with us in America. Influenza now heads the list of epidemic diseases. This fact is strikingly brought out by statistics recently published by the British Registrar-General. He shows that in the 46 weeks from June 23, 1917, to May 10, 1918, influenza caused deaths at the rate of 47.74 per 100,000 population. To find a British epidemic approaching this in severity he had to go back to the cholera outbreaks of 1849, in which the death rate was 30.33 per 100,000. The engineer has played no mean part in vanquishing cholera and typhoid. As yet the medical fraternity has not shown him what, if anything, he can do to prevent influenza sweeping over the country or the world like wildfire. Unfortunately the doctors, notwithstanding earnest concerted effort, have to confess their own helplessness against epidemics of influenza. Once the doctors will point the way, engineers will do their part, if fortunately there is a part for them, to make the world as safe against influenza as it now is against cholera and typhoid and may be made, with the engineer's help, against malaria.

Canadian Rate Hearing

IN EVIDENCE presented before the Board of Railway Commissioners of Canada during the hearing on increasing railroad rates in the Dominion, which ended Aug. 21, the similarities and differences of the case from that in this country was clearly brought out. First the question of a universal wage increase was irrevocably linked up with the question of a blanket rate increase, as in this country. It is generally thought that Canada must meet the recent wage award made here by the Railroad Labor Board. The most striking similarity between the Canadian situation and that in this country, as clearly brought out by the evidence, is reluctance to increase rates to a level that will make "average" lines pay, for fear of too great profit accruing to lines which have greater earning power. This similarity has been noted previously in these columns, but we did not expect that it would be expressed so clearly in formal

evidence as that given by a representative of Western Canada Boards of Trade, on the last day of the hearing, in a statement that the condition of the Canadian Pacific Railway should be considered the basis for rate-making. But here again is the striking difference between the case in Canada and the United States. The whole railroad system of the country, except the prosperous Canadian Pacific, is now operated by the Government, and at a loss. The primary purpose of the rate increase is to reduce a Government deficit but the fear exists that in doing so the great private corporation now earning substantial dividends will profit unduly. At this writing no decision has been reached, but it appears that forthcoming wage adjustments alone would force a rate increase.

The Plight of the Street Railways

THAT the present plight of the street railways is due to their own sins of omission and commission, aggravated by war conditions, and that there are due drastic reforms from the street railways and an assumption of much burden by the public, and that employers and employees must agree to and abide by arbitration because strikes and lockouts are intolerable, is the substance of the report of the Federal Electric Railway Commission, appointed over a year ago by President Wilson. The conclusions of the report are notable not for their novelty but rather because a commission representing the street railways, their employees, investment bankers, the Federal government and the mayors of the country should be unqualifiedly unanimous in its statement of the case and in its conclusions—conclusions (see our News Section) which, on the whole, are constructive and progressive.

What the commission fails to recognize—and this is true of most of the discussions of the street railway situation—is that the existing contracts between the cities and street railway companies are the result of bargaining in which each side made concessions in order to secure provisions that were considered of moment. The inviolability of these contracts has been fought for by the companies in the courts for decades—and has been upheld by the courts in the absence of proof of fraud—regardless of the possible injustice of the contract terms to the cities and the public. But when the war came on and costs went up and the street railways found that the five-cent fares they had eagerly accepted yielded less profit than formerly, or no profit at all, and that they lacked reserve and depreciation funds, then the railways began asking the cities—not to make a new bargain with concessions on both sides, but to consent to rate increases without concessions to the city. The cities should insist on either a reopening of the entire contracts or else an iron-clad provision that any increase of rates granted shall be temporary only.

It is to the credit of the commission that although opposing municipal ownership as a present measure it advocates removing all legal bars to its adoption. This is a principle that has long been maintained by many conservative students of municipal government and of public utilities alike. The legal right to enter upon municipal ownership of any utility if the city authorties or the voters think best is an incentive to good service by the utlity and affords the city a possible means of relief from intolerable conditions.

In passing, we may remark that the commission might well have pointed out the remissness of the cities and the public in protecting their own interests when making contracts.

Finally, the commission's assent to a larger measure of local control over the street railways, while at the same time recognizing the need for a considerable measure of state control, is in line with the trend of sound public policy and the general progressiveness of a report which, if heeded, is bound to aid materially in relieving the street railways from the sad plight into which they have brought themselves and their patrons—a plight aggravated by war conditions but which, sooner or later, was bound to call for drastic remedies even had there been no war.

The Retirement of Charles Whiting Baker

CHARLES WHITING BAKER'S retirement from engineering journalism, announced in this issue, closes a third-of-century of exceptional service to the engineering profession. Those of this, his own generation, need not be told of the influence he has had on engineering progress. Week by week for thirty-three years, and particularly since 1895, when, after years of service as associate editor, he became editor of *Engineering News*, his views and those of his associates under his guidance and counsel have gone out to bid the profession to turn its thoughts now in this direction and now that, have cautioned against danger and false doctrine, have encouraged this reform or proposed that remedy. Always, the controlling thought has been to contribute to the sound progress of the engineer and of engineering. If the termination of his journalistic work be a proper time to judge of the discharge of the heavy responsibility which he has borne, we know that the profession, no less than his associates, will say, "well done."

Without experience as a journalist one can have no conception of the exactions of the work. The extent of the field to be covered alone makes the task an appalling one. Manifestly, no man personally can be an authority beyond a very limited field. He must rely on specialists, but his must be the determination of policy. Nor can policy be lightly determined for a great journal. Along paths of obvious error, no editor can lead, but error does not have to be flagrant to be pernicious. In fact, even when the scales are nearly balanced the potentialities for harm may be very great. The error, then, is difficult of detection, and, under the editor's persuasive pen, gets the greater vogue.

His responsibility is with him daily. He cannot, even if his conscience would allow, become unconscious of it. Daily he has evidence of the vigilance of his readers, in the form of letters of protest. Should he slip, disaster is likely to be the just reward.

It is right that it should be so, for the development of a whole art or of the entire profession is constantly at stake.

The mental and nervous tax is heightened by the element of strife. The editor's path is strewn with the wrecks of controversy. One cannot please everybody. The easy way is to take no strong positions, to be equivocal, to "carry water on both shoulders," but that is not the right way nor the courageous way. One can be honored by the enemies he makes, but the process of making them can hardly be reckoned in the day's pleasures. The offending of those who deserve offense wor-

is none but the weak, but, unfortunately, it is necessary to disagree with those whom one respects and who deserve respect. Satisfaction comes from the consciousness that one has done what to him appears right.

But there are compensations. The editor of a journal that has maintained its prestige can look back on a life of real accomplishment. His name may not be attached to a mighty bridge, he may not have built a railroad through a box canyon, or planned, financed and organized a great industry. But shall we say that he has had no part in these developments? What of the years of inspiration he has given the designer? What of the information he has spread broadcast on economical methods of construction? What of the fruits of the accumulation of data he has made for every branch of his field?

As truly as the designer puts himself into the individual design, so has the editor put himself into the whole art. His influence is there. He has had a part in shaping the progress that shows itself in the best practice of the day. The world at large does not see this, and, not seeing, does not concede. For work well done, personal satisfaction must often be the best reward. So is it generally with editorial work.

Looking back on his long editorial career, and appreciating the part he and his associates have played in the development of engineering and the engineering profession, Mr. Baker has indeed cause for satisfaction. His was the chief responsibility for a journal that was held in exceptional esteem, not only here but abroad. Its accounts and editorial positions were eagerly awaited on all important engineering developments.

To Mr. Baker has come more than to most technical editors, recognition and honor. Blessed with a pleasing personality and with ability as a speaker, he has been much in demand to address engineering assemblies. His careful study of the needs of the profession has caused his views to be sought in the council room. He has been the confidant of the leaders of the profession, arbitrator of controversy.

While his direct connection with technical journalism is now to end, we cannot conceive that his gifted pen will be idle. We know that it will be employed whenever the interests of engineers and engineering are at stake.

Proposed Amendments to the Civil Engineers' Constitution

THE action of the Portland convention of the American Society of Civil Engineers brings to the final step proposals that have been under discussion for many years. It also refers again to the membership the question of affiliation in a specific federation of engineering societies.

Certain of the amendments referred to letter ballot were approved in the questionnaire canvassed in April—those providing for the broadening of the society's objects, for the increase of non-resident dues by $5, for the nomination and election of directors by geographical districts, for the assignment of every member to a local section, for the establishment of an annual conference of the representatives of sections, and the nomination of candidates for office by the annual conference. Previous approval having been given, it is to be expected that these amendments will prevail.

Three proposals are new—those relating to the election of honorary members by two votes less than the full membership of the board of direction, to the elimination of members of the nominating committee as candidates for office, and the reduction of the number of members of the board. The first two of these require no comment. The third needs clarification.

Under the present constitution the board consists of thirty members, of whom at least nine shall be from the New York (resident) membership. Under the proposed amendment, by the reduction of the number of New York directors from six to three, and the elimination of the secretary and of two past-presidents from the board, the membership is reduced to twenty-four. At the same time the requirement that "at least one vice-president" shall be a "resident" member is dropped, so that New York, instead of having a certain membership of nine on the board, will now have only four—three directors and the treasurer. Since this reduction brings New York's representation down to proportionate representation of the remainder of the country the proposal is not unfair to District No. 1.

The reduction in the total membership in the board is desirable, though with the present breaking with the earlier order it is questionable whether it would not be better to retain the past-presidents, for the benefit of their experience, and to cut the number of two-year vice-presidents from four to two.

The justification of the resubmission of a referendum on joining the Federated American Engineering Societies is that the previous vote was taken before the federation was formed, that the basis of representation now puts the large societies on the same basis as the smaller ones, and that the previous proposal was lost by only a small majority. Over this situation it is not necessary to spend time. It has been thrashed out most thoroughly. The decision is now, and finally, in the hands of the membership.

Returning to the amendments, it is worth while to consider the effect of two of them. In the effort at democratization the nomination and election of directors is to be put in the hands of the districts, the theory being, and properly, that the directors will thereby be more responsive to the views of their constituents. At the same time, it is proposed to establish an annual conference of representatives of local sections which, contrary to its original purpose of furnishing a medium for the interchange of views on section management and activities, is to "consider the welfare of the society and its members and report thereon to the Board of Direction." In other words, there is to be set up a body to counsel the board. Under the present constitution, with a board nominated and elected by the society as a whole, there is a feeling that such a counseling body is needed. If the district election plan is adopted the counseling function should be unnecessary. If with directors nominated and elected by them without interference the districts are unable to get their views considered they are not likely to make more of an impression through the conference. As a forum to discuss section activity there may still be a function. As proposed in the amendment, though, it merely increases the machinery of the society without apparent good reason.

Taken as a whole, the amendments run in the direction of the reforms that have long been demanded—a democratization of the society, and a strengthening of the section activities. They will undoubtedly prevail.

The Surface Shrinkage of Rapid Filter Sand Beds

Opinions on the Article by Abel Wolman and Shepperd T. Powell in Engineering News-Record July 2[illegible] 1920—Two Engineers Think Shrinkage Away from Filter Walls Due to Horizontal Pressure —One Believes It a Matter of Physics Rather Than Physical Chemistry—A Fourth Gives More Credence to Colloidal Theory

Physics Rather Than Physical Chemistry

By Robert Spurr Weston
Consulting Engineer, Boston, Mass.

PARTICULARLY interesting is the authors' discussion of the absorptive power of sand grains. The absorption of various collodial matters by sand grains has been frequently noted in the writer's practice. For example, at Middleboro the first water passed through the sand filter was free from iron. A day or two later, when equilibrium was established, that is when the sand became coated with a film of colloidal iron, silica and organic matter, the iron in the effluent increased and has remained practically constant since. It would seem, therefore, that the characteristic absorptive action of a new sand disappears in a short time. To cite an extreme analogy, if one passes an acid mine waste containing iron and calcium sulphates and free acids through a filter filled with lumps of limestone the neutralizing action of the latter is at first prompt and complete. Soon, however, the iron hydrate coats the limestone lumps and the action nearly ceases. So with the filter sand; we must consider aged sand with its accumulated coating—not fresh sand from beach or bank.

While I have had no experience with drifting-sand filters I agree with the authors that the absorptive power of the sand brought into contact with the water is a most important factor in purification by this process.

The authors are to be commended for resorting to physical chemistry to explain sand-layer phenomena, for it is in this field that the progress of the future is to be made. The part played by highly absorptive films on sand grains in the formation of mud balls belongs in this field, and the authors' beliefs regarding the same are borne out in my experience. With them I hope that studies of this nuisance may be continued.

The North Carolina sand reported on by H. W. Clark was not pure silica, and he believed that its cementitious properties were due to the presence of carbonates and hydrated silicates, that is of compounds distinct from the slightly absorptive quartz and quartzite of which most filter sands are chiefly composed. The North Carolina sand was indeed absorptive when new, but Mr. Clark does not state how it differed from other sand of the same size when aged in a filter.

The absorptive character of filter sand, coating and all, probably does affect, perhaps by coherence, the angle of repose of sand under water, and therefore probably interferes with the sloughing off of the sand to fill peripheral voids after they are once formed at the filter edges. In our practice we have noticed cracks and voids in small mechanical filters many times, in slow filters never, and believing that the sand particles simply acted as supports for colloidal films, and that the important characteristics of the particles were their size and shape. I have explained sand-bed shrinkage by physics, and not by physical chemistry.

In the mechanical filter it is quite a frequent occurrence for the higher wash-water velocities to occur at the sides of the filter. The combination of these higher velocities and un-uniform sand will segregate the coarser material at the sides of the filter, with the result that when the filter is next washed, to paraphrase the authors, the water will gush around the open spaces on the sides. In one filter plant under our observation the sand from the side was considerably coarser than that in the center. If the filter sand be segregated according to size in different parts of the filter all parts of the sand layer will not compact to the same degree after washing. The finer sand will shrink the most.

In a recent paper (Proc. Am. Soc. C. E., Vol. 46, April, 1920) Allen Hazen proved conclusively that in large hydraulic-fill dams the pressure of the hydraulically filled cores against the toes of the dams may be reduced —that is, their horizontal pressures may be largely overcome—by using material of large enough size to properly compact. He showed that freshly deposited silts do shrink in volume under water, slowly or more rapidly according to the sizes of their constituent particles. His cases are extreme, of course, but his conclusions apply at least to the finer filter sands.

Shrinkage of Fine Material

If, at the conclusion of washing, the sand in the mechanical filter is so segregated that areas of fine quicksand exist these latter will contract when filtration begins, and if the contracted area be large cracks or voids will appear. It is therefore my present opinion that when a segregated bed is put into service, after washing, the fine sand compacts and the whole bed shrinks. If the sand layer has a high coefficient of cohesion it will shrink away from the walls; if not it will crack. I have seen isolated fine areas contract away from the coarser remainder of the sand layer, leaving circular or polygonal cracks. As the highest filtering velocities are apt to be near the main effluent channel the shrinkage is often radial, and if the sand layer coheres the shrinkage will be most evident at the edge of the filter surface. Once shrunk, I have no doubt but that the absorptive power of the sand grains maintains the bed in its altered position.

To apply the authors' analogy of the syneresis of gelatine: My understanding of what the physical chemists teach is that the large molecules of gelatine, Irish moss and the like, consist of masses of interlaced, filamentous particles, analogous to the spicules of a sponge. When water is added these molecules do not actually dissolve, but the water enters the spaces between the constituent filaments of the molecule and expands it. Heat favors this process of expansion, and we say that gelatine dissolves in hot water. It does not. It becomes what I may call a colloidal quicksand. Now just as the elements of gelatine contract and squeeze out the water, so may sand. There is this difference, however. In the case of gelatine there is a marked

change between the conditions under which the hot water entered the gelatine molecule and those under which the cold water squeezes out. In the case of a mechanical filter bed all except the hydraulic conditions are practically constant. Therefore, notwithstanding the authors' apparently indisputable conclusions, I still look to this variable for an explanation of the phenomenon.

In our practice we have overcome this trouble, which is a serious one from a bacteriological standpoint, by better distribution of the wash water, and by removing the finer particles of sand by washing and scraping. I still believe that the shrinkage will not occur in filters having good wash-water distribution, sufficiently thick gravel layers, and well aged, uniform sand, even though the sand grains be quite fine.

Shrinkage Cracks Due to Colloids

By J. W. Ellms
The Frazier-Ellms-Sheal Co., Cleveland, Ohio

THE authors of this paper have offered possible explanations for the surface contraction of sand filter beds which appear quite plausible. The principles upon which these explanations are based have not received the consideration by engineers to which they are entitled. In 1905 the writer in a paper published in the *Engineering Record*, May 13, 1905, p. 552, called attention to the significance of certain phenomena frequently observed in water and sewage treatment processes which might be explained by principles which were being developed as a result of the study of matter in the colloidal state. During the past twenty years many investigators have contributed a vast amount of data, which, together with the earlier observations of Ruhland. Berzelius, Selmi, Graham and those that followed, have been arranged and classified. A more orderly conception of these highly complex phenomena has resulted. The writer believes that more study should be given to water purification and sewage disposal processes along the lines of colloidal chemistry, and that the physical, chemical and biological problems involved may often be better explained if one is familiar with the principles underlying the colloidal state of matter. Certainly engineering structures can not be properly or successfully designed unless one is familiar with the principles which govern the processes taking place within them. The wide application of the basic principles governing the colloidal state of matter warrants a thorough understanding of the subject if engineering structures are to be intelligently designed.

Bacterial Efficiency and Shrinkage

The authors attribute the poor bacterial efficiency of centain filters which they had under observation to the cracking of the sand beds. The writer has frequently observed these shrinkage cracks in sand beds of rapid filters, but never considered them as contributing appreciably to the poor bacterial quality of the effluents sometimes obtained. In fact, so far as his own experience goes, and that of those operators whom he has questioned, the formation of cracks in the bed always takes place after it has been in service a certain length of time. The writer has never observed shrinkage cracks in new sand beds when first placed in service.

The writer, therefore, concluded that the shrinkage cracks were the result of the accumulation of a certain amount of colloidal organic and inorganic matter upon the sand, which, as is well known, is so necessary for the efficient action of the filter beds. It does not seem as though the adsorptive capacities of the sand grains are of significance except as they play a part in storing colloidal matter. This adsorptive capacity of the sand grains thus becomes an index of the colloidal matter which may be stored in and around the sand grains. The adhesive quality of the sand may be readily explained on this basis.

This conception naturally leads, as the authors have properly concluded, to internal forces within and around the sand particles. We know that the surface energy of a liquid, i. e., the energy upon the interface between itself and its vapor, is equal to the product of the surface and surface tension. Hence by increasing the interfacial surface through an increase of colloidal jellylike substances within and around the sand grains, an increase in the surface energy of the liquid results. That this surface energy may become evident the specific surface (surface divided by the volume) must be at least 10,000. This means that the particles and capillary passages within and around the sand grain must be extremely small. No particle of sand that would be found in any sand filter could possibly provide the surface required if it did not, in addition to its natural superficial area, have an immense internal surface. The additional internal area may be the result of its natural structure and composition plus an acquired area arising from adsorbed and deposited colloidal matter. These areas may be approximately measured by the adsorptive and absorption capacities of the filter sand.

Synerisis of Silicic Acid Gels

It must be admitted that this conception involves, in the case of filter sands submerged in water, the existence of capillary passages, and possibly of the presence of submicrons and amicrons so minute that the interfacial forces obey laws the same or similar to those which would exist if the sand were exposed to the air. The authors have suggested this possibility, and their reference to the "syneresis" of silicic acid gels is apparently put forward as a possible proof of this explanation.

Bütschli has demonstrated the honeycomb structure of silicic acid gels, and has shown, when the gels are partially dehydrated, the existence of minute air spaces within them. Is it not conceivable, therefore, that similar cellular spaces exist within the sand bed of a filter which are never entirely filled with water even though submerged? If this were true would not the interface between the liquid and vapor phases throughout the enormous areas thus made possible provide the necessary energy to produce the phenomenon of surface shrinkage in a submerged sand bed?

The writer believes, as do the authors of the article, that the phenomenon may be extremely complex and that too few data are as yet available to formulate a precise explanation.

The authors have suggested some very practical methods for studying filter sands, and it is to be hoped that their excellent paper will induce a more intensive study of colloidal phenomena, which play so important a part in water-purification and sewage-disposal problems.

Compression of Filter Sands

By Allen Hazen,
Consulting Engineer, New York City

IT seems to the writer that the facts as reported could have been explained more easily. Filter sand is nearly but not quite incompressible. It is slightly compressible mainly because the impurities and small grains in it hold the larger grains from seating as solidly when they first come down in a loose condition after washing as they will do under pressure.

After the sand in a mechanical filter is first washed it is under no pressure beyond that due to its own weight. As the run proceeds the loss of head increases and the pressure, due to the increase in loss of head, is brought to bear upon the surface of the sand bed and tends to compress the sand. At the end of the run a pressure of 300 or 400 lb. per square foot has been developed. The shrinkage due to this pressure is mainly vertical and harmless, but some of it may be horizontal and troublesome. The shrinkage is not enough to have any effect on the filtering ability of the sand, but if the shrinkage is horizontal the cracks resulting from it may have an important influence on the efficiency of filtration. When such cracks are once formed the tendency to compression is exerted horizontally in them on the adjoining sand, thus tending to enlarge and deepen the cracks. The shrinkages described by the authors are probably of this kind.

The amount of shrinkage under pressure depends upon the kind of sand. A pure clean silica sand shows but little shrinkage. Any impurities will tend to hold the grains slightly apart, and will result in a looser position when they first come to the bearing, and more shrinkage will follow when pressure is applied. This is in accordance with the findings of the authors.

The idea of gradual compression of filter sand during the use of a filter is an old one. Kirkwood stated in 1866 that if the loss of head were permitted to go too high it would result in too much compression of the sand and was therefore to be avoided.

The writer's first experience with sand compression was in the St. Lawrence days about thirty years ago. In one of the first water filters there was a marked example of compression of this kind. The filter was in a galvanized-iron tank, 20 in. in diameter and 6 ft. deep. It was one of a number of such experimental filters receiving Merrimack River water. This particular filter ran much longer than its neighbors, and there was much speculation as to the cause. After the run was finished a close examination disclosed it. The sand had been pushed back from the walls of the tank almost down to the gravel, and the raw water had gone down the crack so formed. The sand was in the form of a Pasteur filter bogie surrounded with a thin layer of raw water.

The filtering area was not only the top of the sand but practically the whole area of its sides; and this whole area had finally become clogged and showed the effects of the water that had passed through it. The sand had been compressed horizontally by the increasing loss of head to allow this to happen and to support the whole of the sand as a column. In this case the loss of head was mainly suction, or negative head as it was afterward called. It must have amounted at the end of the run to more than 300 lb. per square foot acting on the top and the whole of the sides of the sand. Why this particular filter sand separated from its walls wh... that in the other filters did not we never knew; but ... was easy to see how, after it once started, the horizont... pressure, acting on the crack as formed, would enlar... and deepen it, until the rather extraordinary result w... reached as above described.

The published Lawrence reports have contained n... mention of this incident. So many interesting thing... happened at Lawrence that it was impossible to includ... them all in the reports. It was necessary to select fo... publication those believed to be of the greatest interes... and to limit the reports to them.

Some years afterward, in the litigation under th... negative-head patent, one of the claims of the patent... was that the increasing head acting on the sand compacted it and made it more efficient as a filtering material. The writer made tests of the amount of compression of sand in actual filters during the course of the run, and with the increasing loss of head. These were made by putting a small plate on the top of the sand and connecting to a delicate measuring apparatus supported rigidly overhead which indicated the drop in the sand level.

Cracks Opened by Compression

The actual compression in the course of runs of mechanical filters tested in this way were found to average about ½ in. Of this about one-third took place at once when the filter was put in service; that is, when the first substantial increment of pressure was brought to bear upon the sand. The remainder developed gradually, and approximately in proportion to the increase in loss of head during the progress of the run.

Looking back after many years it now seems probable that the falling off in efficiency in many of the old English and German filters may be accounted for by passages through cracks opened by compression. It will be remembered that this falling off in efficiency in these old filters was definitely connected in some cases, at least, with increasing loss of head. There was a theory that the filters "broke" when the loss of head exceeded some limit. This theory was widely held. A statement of it is found in Kirkwood's "Filtration of River Waters" (1869; p. 14). The writer encountered it very generally among filter operators in Europe in 1894. ("Filtration of Public Water Supplies," first edition, p. 57 In some cases it was found that the decrease in efficiency was due to the passage of water in the corners of the columns of the vaulted roof and around the ventilators for the underdrains through which unfiltered water found its way ("Filtration of Water Supplies," first edition, p. 17).

To guard against this condition, in the writer's designs horizontal ledges were built on the columns, and the filter gravel was kept away from the bottoms of the walls, permitting the filter sand to come to a bearing on a horizontal surface with which it would make a sure connection that would stop the passage of raw water. This principle in the design of slow sand filters has been generally followed ever since. With slow sand filters so protected there was no "breaking," and the full efficiency has been maintained to the end, even with very high heads. This matter was studied carefully in detail at a number of early filter plants. It was more important before chlorine came into use.

In mechanical filters there is still an idea that filters "break" when the loss of head reaches some limit, and

no doubt in some cases there are results that justify this view. As far as mechanical filters do "break" it is the writer's belief (and has been for years) that the breaking results from the shrinking of the sand away from the walls of the filter, permitting unfiltered water to run down the narrow passages so formed without actually passing through the sand.

Because of the method of washing the simple and efficient measures used in slow sand filters cannot be so easily applied to mechanical filters; and generally speaking the results with mechanical filters have not been such as to cause anxiety in regard to this detail. This is especially true where chlorine treatment follows filtration.

Perhaps it would be well to introduce protective ledges in mechanical filters above the gravel with a view to securing a mechanical seal at that point. At any rate the subject is worthy of consideration.

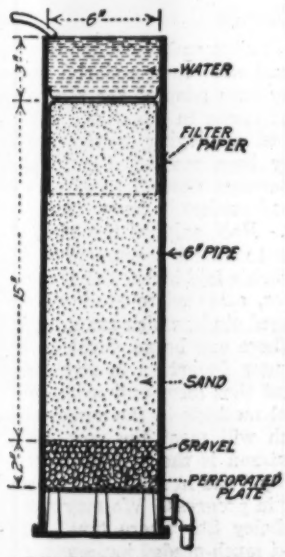
The authors' idea on the absorption power of sand is interesting. This was one of the first subjects studied at Lawrence. The study there was mainly as to the capacity of various sands to absorb coloring matter from the peaty waters that were applied to the experimental filters. Pure quartz has hardly any capacity to absorb and store such matters. The mixed silicates of iron, alumina and lime have considerably varying capacities; so that different sands have very marked individual qualities. Although the subject is an interesting one the writer has always regarded it as a secondary importance in filtration. It accounts for many facts that would otherwise be puzzling.

Shrinkage Due to Horizontal Pressure

By Cornelius M. Daily
Engineer-in-Charge, Supply and Purifying Section, Water Division, St. Louis, Mo.

I HAVE read the very interesting article on "Surface Shrinkage of Rapid Filter Sand Beds" by Messrs. Wolman and Powell and find a few stumbling blocks in the road to accepting their hypothesis.

At various times in the operation of the St. Louis plant a filter bed was washed, filled with water and left out of service for several days without showing any under-water shrinkage cracks, but the same filter bed invariably showed shrinkage cracks when in operation for that length of time. Is it possible that a powerful internal force would lie dormant whenever the filter was idle and be active when it was in use?



MINIATURE TEST FILTER AT ST. LOUIS

The cause of the sand shrinking away from the side walls can be explained without burdening colloids with the task. The filter precipitate which forms a blanket on top of the sand gradually increases the resistance for water to flow through it until a difference of pressure of as much as 6 ft. has been found to exist between the top and bottom of the blanket. This difference of pressure, when great enough, breaks the blanket at its weakest point, which is along the smooth side walls, and allows the water to filter into the area of lower pressure. The water flowing through the break in the blanket carries filter precipitate with it, forming a new blanket on the sand that works deeper and deeper along the walls. This, like the top blanket, resists the flow of water through it, causing a side pressure on the bed which produces the contraction indicated by cracks along the walls.

To prove this theory I constructed a miniature filter (see sketch) and substituted paper for the side as well as the top blanket and produced a crack as wide as ⅛-in. around the wall of the circular bed. Only a few minutes of operation of the miniature filter was required to produce the shrinkage crack.

The phenomena of under-water shrinkage of filter sands do not seem to be fully explained by the hypothesis advanced by Messrs. Wolman and Powell but the colloidal film on the sand grains undoubtedly is a contributory cause.

Chicago Adopts Asphaltic Cushions

THE Board of Local Improvements of the City of Chicago has decided to lay sections of creosoted wood block, granite block and brick pavements on a cushion composed of 92 parts of graded lake sands and 8 parts of asphaltic cement.

This cushion, according to John B. ittell, who was formerly chief engineer of streets for the Board and is now district engineer for the Asphalt Association, will not be as expensive as the 1 to 4 cement mortar cushion and although slightly more expensive than the 2-in. sand cushion previously used under granite blocks, it is believed the resulting benefits will more than compensate for the difference in cost.

Mr. Hittell's estimate of the situation follows:

Chicago has many miles of brick, granite and wood-block pavements laid on sand cushions. A large percentage of these pavements are in streets occupied by street car tracks, and as they are not impervious to water, the shifting of the sand bed, due to combined action of traffic, seepage of water and vibration of car tracks has caused the surface of the pavements to be distorted generally by a settlement of that portion adjacent to the rails and a raising of the part along the quarter or gutter. The displacement has not been uniform and has reduced the life of pavements.

To overcome this objection, especially in brick and wood block pavements, the specifications were changed to provide a cushion 1 in. in thickness composed of 1 part of Portland Cement to 4 parts of torpedo sand or limestone slag screenings. The cement and sand were thoroughly mixed dry and immediately spread upon the concrete foundation, shaping to contour being secured by use of a templet. Immediately before laying the block the cushion was wet by means of a rosehead sprinkler with water merely sufficient to dampen the cushion and set the cement. The result expected from the use of this mortar cushion has not been attained, especially in the case of brick pavements which are deprived of all resiliency and which create considerable noise under traffic. To remedy these difficulties the adoption of the asphaltic cushion was decided upon.

Fuel Oil Pipe Line From Havre to Paris

Construction of a pipe line to convey fuel oil from Havre to Paris has been authorized by the Minister of Public Works of France. The Compagnie Francaise de Transport des Mazouts et Petroles agrees to deliver in Paris a minimum of 2,400 long tons of crude petroleum a day within a year.

Corrosion of Column of High Building Due to Inadequate Protection

By E. H. Eardley
Detroit, Mich.

In the course of extensive alterations to the Detroit Savings Bank Building, formerly known as the Chamber of Commerce, which are being carried out under the supervision of Albert Kahn, architect, a condition of corrosion was discovered in one column which invites the attention of engineers and architects as a warning to use more care in the protection of steelwork, especially where pipes are imbedded in or attached to columns. The photographs herewith show the base of the column in question, where the rusting is clearly apparent, and the building itself, a 12-story structure erected in 1894.

All columns of the building are of the Gray type, made of eight steel angles connected by batten plates. In the original construction, they were fireproof with a 2-in. tile protection around the outside of each column. This in most cases made the interior of the column an inclosed space which would hold water. Moisture or acid that had access to the column exterior could therefore easily work their way to the metal and set up corrosion unnoticed. The particular column shown by the photograph was in the boiler pit, about 2 ft. below the basement floor proper, and 3 ft. away from the nearest oiler. Connected to the column near its base was a water pipe, fitted with a tap used for wetting the cinders. Continual leakage from this tap, together with seepage from the water used to wet the cinders, apparently allowed water to pass through the tile fireproofing and remain in contact with the steel indefinitely, corroding three of the four faces of the column in the manner shown by the photograph.

The interior legs of the angles forming the column were unaffected. Further, this was the only column in the building that was not found in good condition. That the corrosion occurred at the level shown is due to the fact that the top of the boiler-pit floor was at the level of the top of the wing plate; in other words, the corrosion developed just above the pit floor level.

RUSTING NEAR BASE OF COLUMN IN BOILER PIT OF DETROIT SAVINGS BANK BUILDING

Rubber Roads

Although there are places in London and elsewhere where rubber has been used as a road surfacing material over small areas it has hitherto only been adopted for the purpose of deadening the sound of traffic in situations where quiet is essential. The idea of employing rubber on a large scale, however, has long been mooted, but it has been left for the Southwark Borough Council to give this question a definite trial on a road subject to heavy traffic—namely, the Borough High St. Half only of the road is being faced with rubber, so as to afford a comparison in efficiency. The new material is being laid in flat slabs three-quarters of an inch in thickness, attached to steel plates, from which project broadly flanged studs, which are gripped by the concrete foundation. There can be no doubt as to the interest attaching to this new departure in city road construction, and it is significant that local authorities are willing to embark on such novel methods in the search for materials of construction which will meet the new main road traffic conditions. The autumn is the regular season for the roads in London to be "up," and in most of the boroughs important works are now in progress. We may mention, too, the widening of Berkeley St., where that thoroughfare leads into Piccadilly—a much-needed improvement that is about to be undertaken.—*The Surveyor*, London.

Progress Versus Stagnation Is Issue in Am. Soc. C. E. Affairs, Says A. P. Davis

Presidential Address at Annual Convention an Indictment of Standpat Minority Rule—Membership in Federated American Engineering Societies Urged

CHARGING a small but influential minority of conservatives with the domination of the policies of the American Society of Civil Engineers and with opposition to progressive measures designed to expand the activities of the organization and to effect co-operation with the other Founder Societies, Arthur P. Davis, director of the U. S. Reclamation Service, in his presidential address delivered at the fiftieth annual convention of the society, held in Portland, Ore., Aug. 10 to 12, characterized as "progress versus stagnation" the real issue which exists in the administration of the Society's affairs and gave strong endorsement to the movement for a nation-wide federation of engineering organizations as provided for by the recently created Federated American Engineering Societies. President Davis also indicted the ultra-conservative element on the grounds of neglect of opportunities in technical, as well as civic, work. He advocated the termination of the centralized control of the organization which, he claimed, has "hung like a mill-stone about the neck of the society, retarding its growth, restricting its usefulness and threatening it with dry rot." The greater portion of President Davis' address is given herewith:

THE demand for active participation of all engineers in Civil Engineers had they been given proper encouragement and the advancement of the engineering profession has been growing for many years, and is greater today than ever before. Various plans for accomplishing this purpose are suggested, and the pressure has been such that the American Society of Civil Engineers and the other Founder Societies have each taken a more or less active part in such work.

Recognizing the necessity of combining efforts in this line, and also the desirability of somewhat separating such activities from the technical functions of these societies, Engineering Council was formed with the idea that it would represent the four Founder Societies and gradually add to this number through powers conferred upon it for that purpose. It has, in the three years of its existence, added the American Society for Testing Materials and the American Railway Engineering Association, but is still far from embracing all of the engineering societies of the country. It has some fundamental weaknesses. It lacks in representative character and democracy, and is without power to raise funds, but must depend upon voluntary contributions from its constituent societies and others. Experience has shown that these deficiencies can be best remedied by substituting a league or federation designed to include all of the engineering societies, national, state, regional, and local. A constitution to this effect was adopted at the convention held in Washington in June. The federation does not provide for any individual members, but is merely an instrument for combining the efforts of existing societies by forming them into a federation with definite powers and provided with sufficient funds to accomplish its purpose.

The unanimity of the conference was practically complete, with the exception of the American Association of Engineers, a recent organization which has been rapidly growing as the result of active and persistent drives for membership. It fills a niche among engineering societies by admitting large numbers of men working in engineering lines, but without the necessary qualifications to be admitted to full membership in the Founder Societies. It has been quite active and has accomplished good work. It can accomplish still more by continuing its efforts along right lines. But its ambition to be an all-inclusive society, representing all grades of the profession, can scarcely be realized, and seems unreasonable to be expected, and even though it should achieve a greater success than is expected along this line, its prestige is not such as to give it standing comparable to the federation of the four Founder Societies and other large organizations with long standing, prestige and high standards.

Active Minority in Control

In spite of the unanimity of the Washington Convention, there is still a small but very active minority in the American Society of Civil Engineers that opposes this federation and professes to oppose any participation of the American Society of Civil Engineers in civic or other welfare work. Due to the peculiarities of an antiquated constitution, and to a particularly effective organization, this minority has an influence within the society far beyond its numerical strength. Up to date it has, in the main, governed the policies of the society, yielding to pressure only when this became irresistible. It opposed the junction of our society with the other Founder societies in the Engineering Societies Building, and opposed the formation of the United Engineering Society, and successively each and every step tending to co-ordination and co-operation, of the Founder Societies.

In spite of the overwhelming majorities in the recent vote upon Questions 1 and 2 touching the principles involved in the federation, and the recent progressive majority shown by the Committee on Nominations, the conservative element is said to be contemplating an independent or insurgent ticket, supported of course by the usual arguments of caution and conservatism, and utterly ignoring the blunders of the past which such alleged caution has involved.

The real issue in the contest now going on, and especially in the election of directors, which will take place next fall, is whether or not the society is to take its proper place among human activities, or gradually decay and become an obstruction to progress, pretending to fill a niche which it does not fill, and wasting the prestige and history of this glorious Society which ought to be devoted to some end more useful than individual benefits to a small circle of its membership.

Technical Field Neglected

In opposing progressive tendencies the advice is offered that the society restrict its field to technical matters, and leave civic activities to others. This advice would come with more convincing force were it not for the fact that those who offer it have controlled the policies of the society for the past twenty years, and have so neglected the technical field that the demand for technical standards and specifications, which it should have furnished, could be met only by the organization of new societies, such as the American Railway Engineering Association, and the American Society for Testing Materials, whose activities have been largely directed by enterprising and public spirited members of this Society, who could and would have performed the same services through committeees of the American Society of Civil Engineers had they been given proper encouragement and facilities. After having frittered away the opportunities for usefulness and growth in the technical field, it now ill becomes these false leaders to advise us to confine ourselves to the restricted remainder of that field.

The argument usually given is that civic or welfare work might violate the dignity of the society. We might advocate mistaken policies and afterward be obliged to modify these. This is the same excuse given for shrinking its technical duties in the past. It was feared that if our society adopted and uttered standard specifications, these might be found

imperfect or become obsolete, and the necessary changes would reflect upon its dignity. Such argument, if relied upon, would effectually block all attempts at usefulness in any field. It has caused untold damage to this society and to the profession, and should be discarded forever. We should use due diligence and care to avoid errors, but the possibilities of error should not be made an excuse for inactivity.

Whatever the real issues back of the conservative advice, its tendencies are unmistakable. The demand for broader activities is from the country at large, and the opposition is confined mainly to three or four of the large cities. These, with their compact and well organized membership, have been able in the past, with the help of our antiquated constitution, to control the main points of policy of the society, and to perpetuate themselves in power. This domination is threatened by the growth of membership in the rural districts which would be stimulated by the measures proposed by the Committee on Development, especially those measures designed to increase the growth and influence of local sections, and the expansion of activities in accordance with their demands. Every measure that is popular with the membership outside the great cities will add to its growth, and proportionately tend to terminate the centralized control that has hung like a millstone about the neck of the society for so long, retarding its growth, restricting its usefulness, and threatening it with dry rot.

There are thus two distinct issues involved in the pending measures and the coming election of officers. These issues are "progress *versus* stagnation" and "democracy *versus* centralized domination." These issues are largely interdependent, and upon their determination depends the future usefulness and growth of the society. Their importance can hardly be overestimated.

Important Measures Pending

Measures of great importance to the world, to our country and to our profession demand immediate and vigorous attention, and it is imperative that they have behind them the unified efforts of all the organized engineers of the country, and all the prestige that the greatest, the oldest, and the most eminent societies can offer.

Among these measures are the unification of the engineering work of the Government under one department with a technical head. This will promote efficiency and eliminate waste, and, what is more important, will serve as a precedent for the reorganization of other departments along similar lines of homogeneity, efficiency, and economy.

Other important measures pressing for attention are the laws proposed in many states for the licensing of engineers. This policy is steadily progressing. In some states this movement is doubtless inspired by a desire to shut out the competition of engineers from other states, a most destructive policy, and unless some recognized authority, like the federation, backed by both the leaders and the rank and file of engineers, takes a strong hand, we may find ourselves burdened by a mass of pernicious laws that will work untold harm before they can be swept away or otherwise remedied. Properly directed, however, this movement has beneficial possibilities.

We find great disparity between the rewards received by men, and this disparity is by no means in proportion to ability or to any other circumstance which contributed to production. In other words, it is not the man who works the hardest who becomes the richest. It is not he who produces most that receives most. There are problems involved in distribution which have not been solved. Social and economic progress has not kept pace with material progress, and the time has come when the discrepancy must be bridged over, for further increase of production unless accompanied by a more reasonable distribution is likely to become a menace rather than a blessing. It is to the solution of these problems that the leaders of men must give their attention if civilization is to be saved instead of destroyed, as all past civilizations have been.

I have neither the time, the ability nor the assurance to attempt a solution at this time of any of the great problems presented, but will call attention to typical illustrations of what these problems are:

Expansion of Government Activities—The great changes caused by the war and the accompanying upheavals have led irresistibly to larger functions of Government. It has become necessary to increase those function to prevent great injustice and suffering. The control of our transportation lines and other public utilities, once criticised and condemned, is no longer questioned. It is admitted by all to be inevitable and unavoidable. It has even become necessary to control the price of food and of other commodities, and the pressure is strong and the argument almost irresistible for extending this control in many other lines. Rent commissions have been established, arbitrarily fixing the price which the owner may charge for his property, his title to which has never been questioned except in this indirect manner.

The need for these vast expansions of Governmental activities admonishes us that they must be restricted to those cases where such expansion is absolutely necessary. Many who years ago advocated the public ownership of all public utilities such as railroads, gas works, water works, and power plants have in the last five years changed their minds. For one thing, public control through judicial commissions has proved more successful than anticipated, due mainly to an awakened public consciousness, or at least a more enlightened public selfishness. But fully as potent a reason for this changed attitude has been the alarming demands upon the Government for the expansion of its functions in other lines, and it becomes important therefore to confine its functions to those which are inevitable or absolutely necessary. I am therefore in hearty sympathy with many who are now opposing the public ownership of railroads and power plants and commercial shipping. But while agreeing with the conclusions, I must strongly condemn the principal reason which they advance for this. It is common to hear intelligent men whose motives cannot be questioned basing their opposition to Government ownership of railroads on an argument which is condensed into a statement or opinion that "Government operations cannot possibly be as efficient or as economical as those under corporate control." One objection to such a statement is that it is untrue. It has been proved over and over that this is not necessarily the case.

While admitting that there are, and always have been, abuses and defects in our postal system, who would be so bold as to assert, or, if asserted, who would believe the assertion, that our mails would be carried more cheaply, promptly or economically by private enterprise than they are at present.

The public activity with which I am most familiar is the United States Reclamation Service. No claim is made for infallibility or super-human wisdom in the conduct of that service, but its principal officers have always striven for the highest efficiency and economy. It has not been without its mistakes, but results as a whole have proved the fallacy of the theory that the Government cannot do things economically and well.

United Effort Necessary

The preservation of human rights and of the results of scientific progress in the present crisis will require the united efforts of all intelligent, patriotic citizens. In this category I place all engineers; and as they owe a debt of gratitude for the blessings of civilization which they enjoy, they must repay this debt by vigilance and activity in the preservation and improvement of these blessings. Such a program will have its difficulties and its pitfalls; but these will not deter nor discourage worthy men in the pursuit of excellence. Rather, the dangers will serve as a stimulus to activity.

We cannot act effectively unless united, and by calmly reasoning together on pressing questions, guided by the pole star of righteousness, we can unite upon fundamental principles and make our influence for good a power in the land. Only thus can we performe the duty we owe to ourselves, to our fellowmen, and to posterity.

Excessive Rainfall Frequencies at Springfield, Mass.

By Charles W. Sherman
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

IN THE course of a study of the needs of the city of Springfield for new and relief storm sewers the firm of engineers of which the writer is a member made a detailed study of the available rainfall records. It was found that 26 years' records were available from a recording gage maintained by the city of Springfield.

This gage is a Draper pluviometer of the old or tipping bucket type, and was originally installed by the Water Commissioners on Dec. 27, 1891, on the roof of their office building on Bridge St. It was maintained in this position until Dec. 1, 1913, and was then out

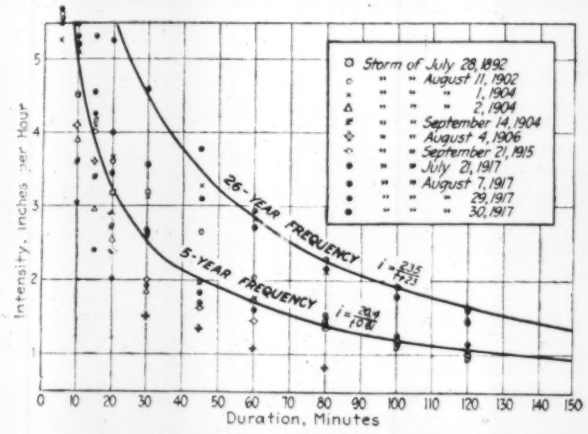

Storm of July 28, 1892
" " August 11, 1902
" " " 1, 1904
" " " 2, 1904
" " September 14, 1904
" " August 4, 1906
" " September 21, 1915
" " July 21, 1917
" " August 7, 1917
" " " 29, 1917
" " " 30, 1917
26-YEAR FREQUENCY
5-YEAR FREQUENCY
Intensity, Inches per Hour
Duration, Minutes

FIG. 1. CURVES OF INTENSITY OF PRECIPITATION AT SPRINGFIELD, MASS., FOR FREQUENCIES OF 26 AND 5 YEARS COMPARED WITH OBSERVED FREQUENCIES IN 11 MOST CRITICAL STORMS

of service for nearly a year, but was re-established Nov. 15, 1914, on the roof of the new city hall and is now maintained by the city engineer. The period of observations therefore includes a little less than 22 years in the original location, and a little more than four years (to the end of 1918) in the present location—a total of almost exactly 26 years, the year 1914 being omitted from the records.

The two locations are in the same portion of the city—that is, on the low plain adjoining the river—and about 1,000 ft. apart. Both of them may reasonably be considered as satisfactory locations as it is usually possible to obtain within a city. The results are subject to the possibilities of error that always obtain in the case of a rain gage mounted upon a roof, particularly when no screens or parapets are provided to minimize the effect of wind currents.

Such elevated gages are frequently checked by comparison with the records of ordinary non-registering gages at ground level in the near vicinity. In this case there was no gage with which satisfactory comparison could be made. The nearest ordinary rain gage is that at the United States Armory, which is about five-eighths of a mile distant and 100 ft. higher in elevation. This locality is on the edge of the plateau overlooking the river plain, and conditions of precipitation may conceivably differ to a considerable extent owing to the difference in locality. Moreover, the exposure of the Armory gage is not satisfactory, owing to the proximity of buildings and trees, particularly the latter. In fact, two large trees almost overhang the gage and there is reason to believe that the records here kept are growing progressively more untrustworthy as the trees increase in size.

A study of the chart records of the recording rain gage showed that during the 26 years there were 67 storms of significant intensity. The data relating to these storms were taken off in figures and tabulated in the usual form to show the maximum average intensity for periods of 5, 10, 15, etc., consecutive minutes. From this table the data relating to most severe storms were rearranged in the order of their magnitude for each period of time. The results are here presented as Table I.

TABLE I.—MAXIMUM INTENSITY OF PRECIPITATION AT SPRINGFIELD, MASS., ARRANGED IN ORDER OF MAGNITUDE FOR VARIOUS PERIODS DURING EXCESSIVE RATE, JAN. 1, 1892 TO DEC. 1, 1913, AND NOV. 15, 1914 TO DEC. 31, 1918.

Order No.	Time in Minutes									
	5	10	15	20	30	45	60	80	100	120
1	8.51	5.48	5.32	5.26	4.59	3.76	2.93	2.30	1.90	1.61
2	6.00	5.32	4.54	3.99	3.55	3.29	2.80	2.19	1.76	1.47
3	5.85	5.21	4.25	3.63	3.20	3.10	2.68	2.16	1.72	1.44
4	5.50	5.10	4.16	3.60	3.14	2.64	2.03	1.53	1.26	1.13
5	5.24	4.50	4.08	3.46	2.66	1.96	1.72	1.44	1.23	1.05
6	....	4.08	4.00	3.21	2.60	1.81	1.60	1.42	1.18	1.02
7	....	4.02	3.88	3.00	2.26	1.66	1.50	1.38	1.17	1.02
8	....	3.90	3.60	3.00	2.20	1.65	1.46	1.29	1.12	.95
9	....	3.60	3.40	2.85	2.16	1.64	1.32	1.14	.99	.90
10	....	3.60	3.20	2.85	2.09	1.60	1.32	1.10	.95	.85
11	....	3.60	3.20	2.85	2.06	1.60	1.30	1.10	.87	.80
12	....	3.60	3.12	2.70	2.00	1.60	1.30	1.09	.84	.75
13	....	3.54	3.00	2.61	1.98	1.58	1.30	1.03	.84	.75
14	....	3.50	3.00	2.55	1.91	1.54	1.29	1.02	.80	.72
15	....	3.36	2.92	2.55	1.86	1.48	1.28	1.00	.80	.71
16	....	3.30	2.80	2.40	1.82	1.47	1.27	1.00	.80	.70
17	....	3.30	2.80	2.40	1.80	1.47	1.21	.98	.79	.67
18	....	3.24	2.64	2.39	1.80	1.46	1.20	.97	.78	.67
19	....	3.20	2.60	2.28	1.76	1.44	1.20	.89	.72	.65
20	....	3.18	2.60	2.25	1.76	1.43	1.10	.82	.72	.62
21	....	3.18	2.44	2.19	1.64	1.36	1.07	.82	.70	.60
22	....	3.18	2.41	2.10	1.60	1.36	1.02	.81	.67	.59
23	....	3.03	2.40	2.10	1.60	1.23	.99	.80	.65	.57
24	....	3.00	2.40	2.07	1.60	1.21	....	.78	.64	.53
25	....	3.00	2.40	2.00	1.56	1.14	....	.76	.63	.53
26	....	2.76	2.40	1.96	1.50	....	....	.75	.55	.51
27	....	2.76	2.32	1.95	....	....	....	.73	....	.50
28	....	2.64	2.28	1.95	....	....	....	.68	....	.50
29	....	2.45	2.28	1.89	....	....	....	.64	....	.50
30	....	2.29	2.20	1.83	....	....	....	....	....	.48
31	....	....	2.20	1.80	....	....	....	....	....	.48
32	....	....	2.20	1.68	....	....	....	....	....	.48
33	....	....	2.20	....	....	....	....	....	....	.47
34	....	....	2.12	....	....	....	....	....	....	.47
35	....	....	2.12	....	....	....	....	....	....	.45
36	....	....	2.02	....	....	....	....	....	....	.42

Note: Record obtained by Draper Pluviometer (old style).

The figures in this table furnish the data for plotting directly intensity curves of 26-, 13-, 8½-, 6½-year frequencies, etc. By interpolation between curves so drawn curves for 20-, 15-, 10- and 5-year frequencies can be constructed.

It is found that the following formulas satisfactorily represent the intensity curves for the frequencies shown: Once in 26 years $i = \frac{235}{t + 23}$; 13 years, $i = \frac{250}{t + 38}$; 5 years, $i = \frac{20.4}{t^{0.61}}$. In these formulas i represents the intensity, or average rate of precipitation, in inches per hour, and t represents the corresponding duration of time in minutes.

It is of significance to know the number of storms exceeding the intensity shown by various curves, as well as to know the number of times when the intensity indicated for definite periods of time has been exceeded. Fig. 1 shows the observed intensities for various periods of time in the eleven most significant storms covered by the observations, together with the curves of 26-year and 5-year frequency. It will be noted that the

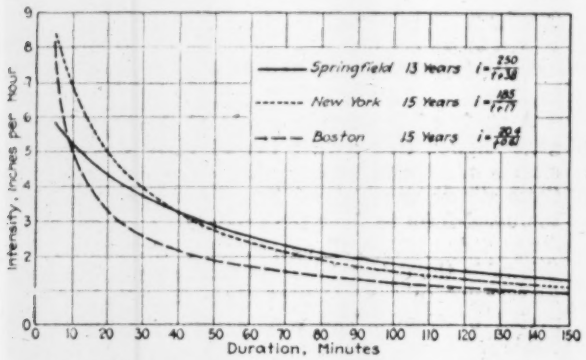

Springfield 13 Years i=250/t+38
New York 15 Years i=185/t+17
Boston 15 Years i=20.4/t^0.61
Intensity, Inches per Hour
Duration, Minutes
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0 1 2 3 4 5 6 7 8 9

FIG. 2. COMPARISON OF RAINFALL INTENSITY-FREQUENCY CURVES AT SPRINGFIELD, NEW YORK AND BOSTON

26-year curve is governed by a single storm—that of Sept. 21, 1915. The 13-year curve is governed at some points by the storm of Aug. 30, 1917, and at other points by that of Aug. 1, 1904. It will also be observed that during the 26 years there are but four storms which materially exceeded the curve of 5-year frequency, and two of these occurred during the year 1917.

As an indication of the changes in intensity of rainfall from place to place it is significant to compare the intensity curves for Springfield with those obtained for Boston and New York City. Data relating to the precipitation at Boston, as shown by the 38-year record of the automatic rain gage at Chestnut Hill reservoir and the 26-year record of the Weather Bureau gage on the post office building at Boston, are given in a paper entitled "Maximum Rates of Precipitation at Boston for Various Frequencies of Occurrence," by Harrison P. Eddy, (Jour. Boston Soc. C. E., Feb., 1920). Corresponding data for New York City, compiled from the records of 15 years, are contained in the report of a committee of the Society of Municipal Engineers of the City of New York, published in the *Proceedings* of that society for 1913. Table II contains a comparison of the intensity curves for approximately corresponding periods, and Fig. 2 shows graphically the comparison of curves for 15-year frequency (13 years at Springfield). These comparisons show that the Springfield intensity and frequency curves correspond closely with those for New York City, and are materially higher than those for Boston. In fact, the Springfield curve for 5-year frequency is identical with the Boston curve for 15-year frequency.

TABLE II—COMPARISON OF RAINFALL INTENSITY CURVES FOR SPRINGFIELD, NEW YORK AND BOSTON

Place and Frequency	Expression for Intensity, i, Inches per Hour	Intensity, i, in Inches per Hour, for Duration, in Minutes									
		5	10	15	20	30	45	60	80	100	120
New York 45 years	$\frac{260}{t+18}$	11.30	9.30	7.89	6.85	5.40	4.12	3.33	2.65	2.20	1.8[illegible]
Springfield 26 years	$\frac{235}{t+23}$	8.40	7.13	6.19	5.47	4.44	3.46	2.83	2.28	1.91	1.64
New York, 22½ years	$\frac{220}{t+18}$	9.56	7.87	6.67	5.80	4.58	3.48	2.82	2.24	1.86	1.59
Boston, 38 years	.....	9.10	6.70	5.40	4.65	3.60	2.58	2.06	1.70	1.45	1.29
Springfield, 13 years	$\frac{250}{t+38}$	5.81	5.21	4.71	4.31	3.68	3.01	2.55	2.12	1.81	1.58
New York 15 years	$\frac{185}{t+17}$	8.41	6.85	5.78	5.00	3.94	2.98	2.40	1.91	1.58	1.35
Boston, 15 years	$\frac{20.4}{t^{0.61}}$	7.64	4.95	3.91	3.28	2.56	2.00	1.68	1.41	1.23	1.10
Springfield, 5 years	$\frac{20.4}{t^{0.61}}$	7.64	4.95	3.91	3.28	2.56	2.00	1.68	1.41	1.23	1.10
New York, 5 years,	$\frac{130}{t+17}$	5.91	4.82	4.06	3.51	2.77	2.10	1.69	1.34	1.11	0.95
Boston, 10 years	$\frac{125}{t+20}$	5.00	4.17	3.57	3.12	2.50	1.92	1.56	1.25	1.04	0.89

Water-Supply Problems and Projects in California

By C. G. Gillespie
Resident Engineer, Filtration Division, City of Sacramento
Lately Engineer, California State Board of Health

CALIFORNIA is experiencing the scantiest rainfall in ten years, while at Sacramento this is the ninth of a succession of dry years. These facts are driving home to Californians the fact that the full development of the great resources of the State—and the growth of its cities, therefore—will from this time on be measured primarily by the enterprise with which great projects for both irrigation and domestic water supply are undertaken.

To those unacquainted with California its topography must be understood to appreciate the remarks to follow. From the aviator's viewpoint the State is flanked by the Coast Range Mountains along the Pacific, and the Sierra Nevada Mountains along its eastern boundary. Both mountains link together to enclose the great valleys of the Sacramento and San Joaquin, whose rivers, bearing the same names, join and break through the Coast Range via San Francisco Bay and the Golden Gate. South of the southern end of the link lie numerous disconnected ranges and valleys, chief of which is the Imperial Valley and the valleys of Southern California lying about Los Angeles. Within the Coast Range the streams, in general, flow parallel to the range and finally break through it, by a curious geological process, to the Pacific Ocean. The early development of the State occurred in these minor valleys and they are still the seat of some of the best agricultural prosperity. In more recent years, however, attention has been directed to the great valleys of the South and the interior.

The development of the Imperial Valley through diversion of a portion of the Colorado River on the Mexican side across into California is well known. But problems of tremendous magnitude have appeared through the gross waste of water from the canal on the Mexican side and the silting up of canals and laterals due to the 20 tons or more of dry silt per million gallons carried by the Colorado River water. Relief from the first condition is proposed by constructing an all-American canal costing millions. To the knowledge of the writer, no improvement is in sight to desilt canals other than that of dredging as is now the custom.

All the towns in the Imperial Valley depend on the silt-laden canals for municipal supply. Advantage is taken of a most peculiar natural coagulating property of the Colorado River water whereby the finest of silts settle out quite completely in standing for a day or so. But the results are erratic, especially during seasons when one of the tributaries, the Gila River, is in flood. At that time coagulation is lacking and sed

imentation slow. To supplement sedimentation, three of the cities of the valley have already put in slow sand filters equipped with Blaisdell sand washers, to supplement sedimentation, and quite good results are obtained.

In the vicinity of Los Angeles there has taken place the maximum development of wells in the granitic formation underlying the region. Los Angeles itself, that dauntless city of the West, has spent millions to obtain its Owens River supply *257* miles distant at the south base of the Sierras. An attendant problem, perhaps not fully anticipated, however, is the considerable development of algae to which these mountain waters become at once subject when mixed with the runoff of pollution-carrying lower watersheds. On a large scale the primary cause of this algae growth cannot be controlled and so it is likely that the customary algae problems must be met and solved with perhaps a better understanding that will permit of a more accurate prediction of the rise and disappearance of groups, and of the need and time and amount of treatment.

ARCHITECTS' CONCEPTION OF PUMPING STATION AND FILTER HEAD HOUSE FOR SACRAMENTO WATER-WORKS
The pumping station, at the left, will house electric-motor-driven centrifugal pumps.

San Francisco has voted $45,000,000 to go across the San Joaquin Valley to the headwaters of the Tuolumne River in the Sierras for its future water supply. In the face of dramatic obstacles the work still proceeds, as has been frequently noted in *Engineering News-Record*. This same river also furnishes all the irrigation water for one of the larger irrigation districts of the State, the Modesto-Turlock District, and not only this district but many outside people as well view with alarm a program which does not recognize that irrigation has first claim on streams in the vicinity, over cities in the State which can harness and redeem other more useless waters.

In the East Bay Cities (Oakland, Berkeley, etc.) the water situation is most acute. Near-by streams and undegrround supplies have been practically all developed by the local water company and the inhabitants are on a strict economy consumption of something like 60 gal. per capita per day. These cities are casting about for a more copious supply but decision is yet to be reached. A recent engineering report considered two main projects—one to bring water from the McCloud River, a tributary of the Sacramento, in the Sierras *225* miles distant at a cost of $75,000,000 to $105,000,000, and the other to divert the Eel River, a Coast stream, from a useless course northward to the sea, to a useful one southward through one of the Coast Range valleys, a distance of 127 miles, across San Francisco Bay to the East Bay Cities. The initial installation of the project is estimated at $45,000,000. Still another project suggested, probably far more economical, contemplates the pumping of the Sacramento River from a point near its mouth, during flood months when tidal salinity is lacking, into the artificial lakes and reservoirs surrounding the East Bay Cities, from which it could be filtered and distributed as needed.

In the Sacramento Valley irrigation water has always been plentiful for the land hitherto supplied. In the past few years, however, undreamed-of agricultural development of the upper valley, particularly in rice farming, has taken place and this river, once considered inexhaustible, has this year been nearly blotted out. It has been so dried up that the towns along its lower stretches and the long-established and fertile delta region, claiming ruin by the backing up of saline tide water past their doors, have instituted a "$60,000,000 suit" against the rice growers and other users, and the upper users themselves have been obliged to pool their interests in the stream and allow for its distribution by a water master to save the crops planted this spring.

The situation in the interior valleys has given rise to at least two proposals for permanent relief. One is the so-called Iron Canyon project whereby some of the flood waters of the Sacramento River could be stored in an artificial reservoir near its headwaters, which could add some 150,000 or 200,000 acres to the irrigable area. The other is a most colossal scheme, with good engineering backing, which contemplates diverting the Klamath River, which now runs a useless course through the wild hills of the north, through the range into the Sacramento watershed. The combined rivers would then be diverted into two tremendous meandering high-level canal systems flanking the interior valleys their entire length, picking up and storing all waters caught along the way and delivering them where needed for power, irrigation and domestic supply. Press reports place the estimated cost at something like $800,000,000 and the area to be benefited at 12,000,000 acres. As a project for conservation of the State's water, and for insuring almost the maximum development of its

unclaimed millions of acres, it has no equal. Little discussion has been given the matter, perhaps because its magnitude is overwhelming. Editorials in some of the local papers, however, point to the administrative difficulty of getting the consent of existing irrigation developments to a sacrifice of their rights and holdings. It is likely that the State must pass through more than this trying drought before it will take seriously this master project of all.

In water filtration California has been most backward. Last year, however, the City of Sacramento took the lead in voting $1,800,000 bonds for a strictly up-to-date filtration plant of 32,000,000 gal. capacity and opportunity to quadruple the plant. The supply is obtained from the Sacramento River and has been becoming steadily more foul due to settlement of its watersheds and the valley above, and especially to the rice industry, which has set up conditions rich for the development of algae. Anabena, for instance, has been prevalent as high as 4,000 standard units per c.c. all summer long. Tidal action now carries the city's sewage backward, and a new intake farther up the river is badly needed. In winter the stream is a turbid torrent due to soil erosion.

The new water-works will include an attractive mass concrete intake pier in the river, gravity conduits to a pumping station about 1,100 ft. inland, low-lift pumps delivering to the treatment works, high-lift pumps pumping direct from the filtered water storage to the city at 75 lb. pressure, grit basins, coagulating basins, coagulant manufacturing house, head house, filters and filtered water basin. Design of the water-supply end is completed and bids for the work are soon to be received. Plans for the treatment works are being made by a special staff appointed for the purpose. Experiments on special phases of filtration—pipe underdrains, coagulating, benefits of aëration, air-binding of filters, and local deposits of bauxite—have been of invaluable aid in prescribing the most suitable design.

COMPARATIVE COST ESTIMATES OF VARIOUS TYPES OF WATER-WORKS PUMPING EQUIPMENT FOR SACRAMENTO, CALIF.

Type of Station	Cost to Construct	Yearly Charges for 20 M.G.D.
Main unit reciprocating, high duty, other units steam-turbine centrifugal	$803,000	$154,650
Steam-turbine-driven high-lift centrifugal pumps, balance motor driven from turbo-generator	521,000	146,700
All units steam-turbine centrifugal	450,000	148,140
Diesel generator, motor-driven centrifugal units	610,000	124,000
Electric station, motor-driven centrifugal pumps, power purchased at approximately 1c. per kw.-hr.	190,000	104,000

Motor-driven centrifugal pumps will be used for the entire pumping station. Comparative estimates of the first and yearly costs of the various types of pumping equipment are given in the accompanying table. A network of hydroelectric power lines intersect in Sacramento and the engineers did not hesitate to recommend the selection of a motor-driven station.

Where Gas Is Cheap and Getting Cheaper

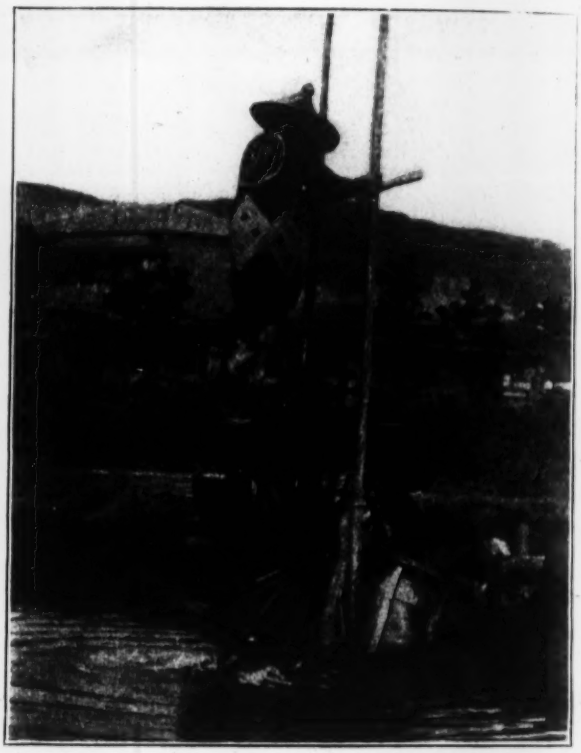
A reduction of the price of gas to 1s. 6d. per 1,000 cu.ft. for lighting and heating and to 1s. 4d. for power (36 and 32c.) has recently been announced by the Sunderland Gas Co. of England. The London *Engineer* states that the reduction, in spite of the "higher price of coal for domestic purposes is due entirely to the better prices obtained for residual products."

Water Supply for Irrigation in China

By Donald F. McLeod

THE writer has traveled by rail and ferry between China and Japan twice, once in winter and once in summer. The most noticeable feature of the landscape, to him, is the way the rice fields are laid out and the irrigation systems installed in connection therewith.

The fields, or paddys, average small, usually half an



MAN POWER RAISES WATER FOR IRRIGATION

acre, or less. They are arranged in a series of steps, with usually one or two feet difference of elevation. In some instances the steps are much greater and a series of fields extends for a hundred feet difference of elevation up a mountain side. In this case the irrigation is from a spring and the water flows down from field to field. The usual scheme of irrigation is to run a ditch a mile or so in length from a low dam across a stream. The ditch is carried across low places in a wooden flume, although in many instances it is carried on the top of an embankment along the sides of which trees are planted to keep the slopes in place.

Where the ditch is a few feet below the level of a rice field three ingenious devices are used for raising the water by man power. The writer believes the first to be of Chinese origin; the second, Korean; the third, Japanese.

The first device consists of a shallow basin to which is attached two pairs of ropes. A Chinaman on each side grasps one pair. When he and his *vis-à-vis* lower their arms the basin drops into the pool below. When both men pull horizontally opposite to one another a toggling action is produced, the basin rises to the required height, and the contents are thrown out into a sluice, due to the upward motion being halted.

The second device has a pendulum-like action. It is hung from a sort of tripod and is operated by one man. An elongated trough-like device of wood scoops up water at the lowermost part of the pendulum stroke and discharges it when the stroke has reached its greatest amplitude. Apparently, the muscular exertion required to operate the device is small, as the rope from the top of the tripod sustains the weight of the "scoop" and its contents.

The third device, shown in the accompanying photograph, is the most elaborate and ingenious of all. It is built on the general lines of an undershot water wheel, or, perhaps, a breast wheel. The operator treads on the vanes on the downstream side, and the wheel, revolving backward, lifts the water and discharges it at the breast of the wheel. This device, like the two others, is portable, and is set up anywhere, ready for action. The vertical "carrying" poles have three functions: To help anchor the machine in place; to help the operator balance himself as he stands treading; to carry the machine when it is moved. In transport the operator carries the whole outfit easily, balanced on his shoulder.

Water Use Variation in Completely Metered Systems

By Allen Hazen
Consulting Engineer, New York City

ONE of the functions of a distributing reservoir is to balance hourly fluctuations in flow. This is not the sole object of a distributing reservoir but it is important to know how much storage is required when this standpoint alone is considered. Data bearing upon this subject were presented by John R. Freeman in his report upon the Water Supply of the City of New York, in 1900, and these have been commonly used as a basis of estimate in the writer's office for the last twenty years. The following study was made to get new data from completely metered systems.

Data from Springfield, Mass., Hartford, Conn., and Superior, Wis., were used. The record in each case was the graphic record of a self-registering venturi meter, arranged so that the whole flow and all fluctuations in consumption were shown by it. These records were kindly furnished to the writer by the engineers of the several systems and were for the year ended May 1, 1920. Census populations for Jan. 1, 1920, were used, adjusted to include outside populations supplied.

The Springfield record was first examined for the whole period of 366 days. Afterward a shorter calculation, using only twelve days (the 15th of each calendar month being selected), gave practically identical results, and only the shorter calculation was used for Superior and Hartford.

The results are shown in three diagrams. Fig. 1 shows the rates of output in terms of mean flow. In a general way the minimum rate of flow is found to be nearly 0.5 of the mean; and the flow is below the mean for about 50 per cent of the time. The lines representing the rates of flow curve sharply upward near the right-hand side of the diagram. In other words, there are high rates of draft that occupied only a small percentage of the total time. To show this more adequately a small inset diagram was made on 10 times the scale. Fig. 2 shows the same data but calculated on a basis of gallons per capita daily above and below the mean. This is the basis that Freeman used and it is convenient and useful. This diagram shows that the minimum rate of flow is about 42 gal. per capita less than the mean. The flow is above the mean by more than 20 gal. per capita for about 28 per cent of the time, and exceeds the mean by 50 gal. per capita for very short periods. Fig. 3 shows the average hourly variation in rates of draft throughout the day for Springfield. Three lines are shown, representing Sundays, Saturdays and all the other days of the week taken together. Each is the average for 12 days, one from each month of the year.

These data include whatever fire drafts actually occurred, and there were, no doubt, the usual number of fires in each of the three cities. Practically the amount of water drawn for fire service has no influence that can be detected in the diagrams. At Springfield much more water was drawn for flushing snow from the streets than for fires.

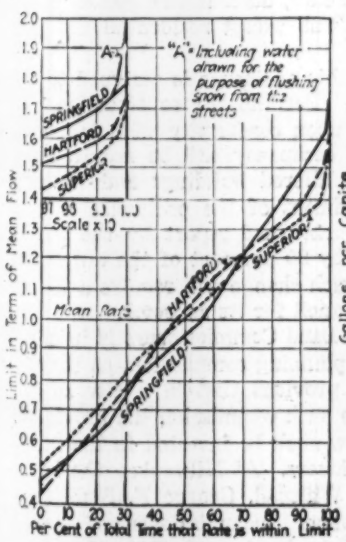

Limit in Term of Mean Flow
"A" Including water drawn for the purpose of flushing snow from the streets
SPRINGFIELD
HARTFORD
SUPERIOR
Scale x 10
Mean Rate
Per Cent of Total Time that Rate is within Limit

FIG. 1. IN TERMS OF MEAN

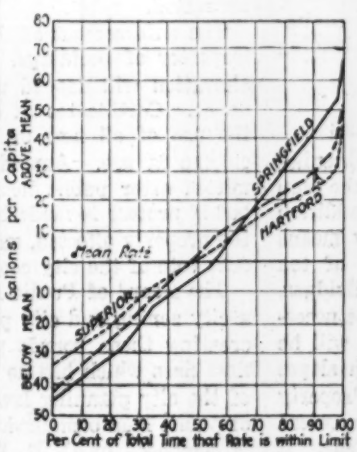


FIG. 2. ABOVE AND BELOW MEAN

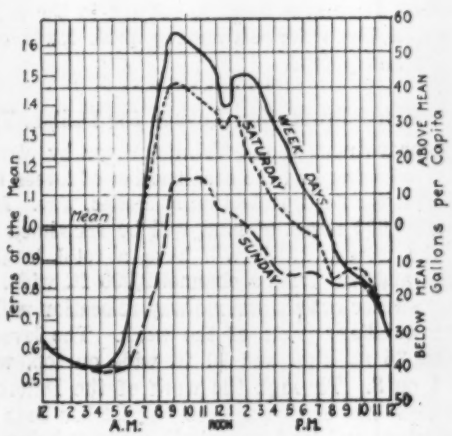


FIG. 3. IN HOURLY RATE

FIGS. 1 TO 3. VARIATION OF WATER CONSUMPTION IN COMPLETELY METERED WATER-WORKS

The average amounts of storage required to balance hourly fluctuations are obtained by planimetering these diagrams. The average for the three systems is found to be 14 per cent of the mean flow, and this is equal to 11 gal. per capita.

A number of data for the three systems are as follows:

	Population	Average Consumption, M.G.D.	Gallons per Capita, Daily	Required Storage to Balance Hourly Fluctuation in Rate of Draft: Million Gallons	Per Cent	Gal. per Capita
Hartford	170,000	12.85	75.6	1.76	13.7	10.3
Springfield	141,700	12.21	86.2	1.83	15.0	13.0
Superior	39,654	2.87	72.4	0.33	11.5	8.3
Totals and averages	351,354	27.93	79.5	3.92	14.0	11.2

At Springfield it was possible to check the results by an independent procedure. The water is delivered to the city from a masonry service reservoir of known dimensions. The records from a self-recording gage furnish data for computing the daily and weekly storage requirements. Data for three selected weeks showed an average daily variation in water level of 3.02 ft., representing a capacity of 2,000,000 gal. or 14.2 gal. per capita. This result compares with the 13 gal. per capita computed from the venturi meter readings and the check is as close as could be expected.

In addition to the hourly fluctuations this reservoir balances in considerable measure the daily fluctuations during the week. It fills higher on Sunday night than at other times, and reaches a weekly minimum on Saturday morning. The average weekly variation is found to have been about 3,720,000 gal., or 26 gal. per capita. While changes were being made at the filters the capacity of the reservoir was availed of to a greater extent, and in one week of maximum requirements the utilized storage was 8,350,000 gal., which is equal to 59 gal. per capita. This was slightly more than half of the available capacity of 16,000,000 gal., or 113 gal. per capita.

These data give a good idea of the storage required to meet daily and weekly fluctuations in completely metered systems. They do not give any indication of the amounts prudently held in reserve for conflagrations and other emergencies; and amounts allowed for such purposes must of course be added to the daily requirements. They also furnish, subject to the same limitations, a basis for estimating peak loads on leading mains and pumps.

Flood Protection Levees for Dallas, Texas

Improvement of the Trinity River by straightening and deepening and the construction of levees is the plan adopted for flood protection at Dallas, Tex. In addition about 4,000 acres of land will be reclaimed by means of the levees, which will have a total length of ten miles and will form a channel 2,000 ft. wide. Bridges, storm-water outlets and railway relocation will be necessary auxiliary parts of the work. The levees will be about 35 ft. high and 10 ft. wide on top, with slopes of 1 on 3. Through the work of the Dallas Property Owners' Association a levee district has been organized and plans and land appraisals are now being made. It is expected that these preliminaries will be completed in time to petition for a bond issue in 1921. E. N. Noyes is engineer for the Dallas and Dallas County Levee Improvement District.

City Zoning Plan for Milwaukee

A CITY zoning ordinance for Milwaukee, Wis., drafted recently by the Board of Public Land Commissioners, provides for districting by use, height and area of buildings. The ordinance is to be submitted to the city council at an early date.

For area of buildings, there are four classes of districts, with restrictions controlling the percentage of the lot which may be built upon and the minimum size of yards and courts from which light and air are received, in accordance with the height of the structure. For residential buildings, these open spaces must extend from the ground; for other buildings they are to extend from the top of the first story. In *A* districts, residence buildings may occupy 70 per cent of the area of an interior lot or 85 per cent of a corner lot, but other buildings may occupy 90 per cent of interior lots or 100 per cent of corner lots. In districts *B*, *C* and *D*, a building may occupy 70, 50 or 30 per cent of an interior lot, or 85, 60 or 40 per cent respectively of a corner lot. The number of families per acre is restricted to 50 in *C* districts and 20 in *D* districts.

Height Restrictions

For restriction in height of buildings, there are four classes of districts with limits of 125, 85, 60 and 40 ft., and with a corresponding limit on the number of stories in residences. In the districts for 125 ft. height, tower buildings are permitted for a total height of 225 ft. over 25 per cent of the lot area. Chimneys, elevators, tanks and similar structures are not limited.

For restriction of use of buildings, four classes of districts are employed. No existing uses are stopped, but any change must be toward conforming with the restrictions. In "residence districts" the ordinance permits dwellings, hotels, clubs, churches, educational and philanthropic institutions, railway passenger stations, greenhouses and farming. In "local business districts" there are permitted retail stores, the making of products chiefly for sale on the premises, public garages and other uses supplying local needs. In "commercial and light manufacturing districts" all uses are permitted except such industries as emit odor, dust, smoke, gas or noise. In "industrial districts" all except residential uses are permitted.

The enforcement of this ordinance is assigned to the inspector of buildings. Permits for construction and alteration will depend upon conformity with the ordinance. Certificates of occupancy will be required for the use of all new or altered buildings and for any change in use. Amendment of the ordinance is permitted after public hearing and report by the board, but if protest is made by 20 per cent of the owners of the property affected, such change will require a 75 per cent vote of the city council for its approval.

The Board of Public Land Commissioners is in effect a city zoning and city planning commission, as the law creating these boards provides that in a city of the first class which has no such commission the provisions of the city planning law shall be invested in the board of public land commissioners. At Milwaukee, the board is composed of C. B. Whitnall, George F. Stall (city engineer), Percy Braman (commissioner of public works), William H. Schuchardt and Edward Grieb; Arthur C. Comey is consultant and R. E. Stoelting is city planning engineer.

How Los Angeles Meters Aqueduct Water for Irrigation

Meter Case for Each Irrigator, but Moving Parts Transported From Consumer to Consumer in Ford Car by Zanjeros

SINCE surplus water from the Los Angeles aqueduct became available for irrigation in the San Fernando valley the irrigated area in that district has steadily increased until 60,165 acres have been brought under the ditch. This is largely held in small tracts, the water requirements of which vary materially. Water is distributed in pipes under pressure, the services to individual consumers varying in size from 2 to 6 in. A total of more than 2,000 services have been installed of which about 1,200 are of the 4-in. size. The rate established for irrigation water is 1.4c. per hundred cubic feet, with a minimum charge of $2 per irrigation.

The ordinary weir method of measuring the water supplied to each consumer was not considered because the pressure in the distributing system fluctuates considerably. Means of recording the total quantity passed under varying pressure was required. After some study Trident crest velocity meters were made standard for the entire system, 2, 3, 4 and 6-in. sizes being used. At first only about half as many meters were bought as there were services to be metered. The meters were taken out and moved from one service to another as water was to be delivered.

This proved too costly in time and labor so tests were made to see whether the meter main casings could be left in place and the moving parts interchanged without introducing material error. The error was found to be so small that it was considered negligible for use such as this. Accordingly main casings were purchased and set on all services and about half that number of moving parts are in use. The zanjero moves these from casing to casing as each tract receives its water. The bronze covers containing gear train and register are numbered and a record is kept of the date and location each time one is used, but the propellers are not numbered and are used promiscuously with any casing or cover of corresponding size.

The zanjero is provided with a Ford equipped with a rack for carrying the meter parts. He goes about alone from service to service, taking out or putting in meters according to a prearranged schedule. It takes him on an average of 8 to 10 min. to open or close the valve, put in or take out the moving parts, read a meter and make a record in his field book. A special brace-wrench is used for tightening nuts on stud bolts in the meter head so that a minimum of time is required for this operation. The parts removed are inspected to see if anything has gone wrong during service and record is made of anything that might affect the accuracy of the reading.

The meters are not used under heads of less than 8 ft. Sometimes when the demand is heavy there is a considerable velocity head in the mains near the upper end of the district. This reduces the effective head on the services in this section which approaches the lower limit even under normal conditions. Thus there are times when the desired flow would not be delivered by the standard meter. To meet this condition in the 4-in. meter, for example, a complete set of moving parts for a 6-in. meter is used in the 4-in. main case. This increases the flow about 19 per cent because of the decreased resistance. The propellers of 3-in., 4-in. and 6-in. meters are interchangeable, the only difference being in size of openings between vanes.

In order to save the wear on the small meters which work at relatively higher speeds, and to avoid choking the flow unnecessarily, the custom is to use a propeller and cover of larger size than the main casing where there is departure from the standard, choking the service gate down as may be necessary to keep the discharge within the desirable limit. This limit is set as not more than 495 gal. per min. for 3-in. meter, 900 gal. for a 4 in. and 2,025 gal. for a 6 in. meter.

Although standard combinations are used whenever possible, to meet emergent conditions, a table of corrections has been prepared by means of which the actual amount of water delivered can be determined from the record made with any combination of gear train and propeller. For example if a 4-in. cover containing gear train and register was placed on a main case containing a 3-in. cage and propeller, the registration would be 154 per cent of true reading. The various combinations give corrections ranging from 30 to 331 per cent.

The plan of using comparatively expensive meters on an irrigation system has worked out to the entire satisfaction of city officials. It prevents the diversion of any water except when it is being charged to the consumer, because the valves are left locked. The aqueduct water carried practically no sediment after passing through the several reservoirs and there has been but little damage or abnormal wear on the meters from any cause.

Important Changes in Mechanism

Some minor but nevertheless important changes in the mechanism of the meter have been made to make it more suitable for interchangeable use and to prolong its life under rather severe conditions of service. Some of these are as follows: The bronze propellor cage was machined to taper, leaving only a narrow ring at the base to serve as a cut off in the main case bearing. This eliminated the sticking experienced at first and greatly facilitated the removal of propeller cages. The agate bearing at the base of the propeller shaft was made as an adjustable agate sphere so that when it had worn on one surface it could be moved to another. At the same time a thumb screw was put in so the height of this bearing could be adjusted to compensate for wear that reduced the length of the propeller shaft. The pitch of the vanes in the 2-in. propellers was reduced and the change gears adjusted to suit. The decreased speed resulting from this change accomplished the double purpose of reducing the choking effect in the meter and lessening the wear. The lower side of the gasket, which goes between casing and cover, is always given a coat of graphite before the joint is made. This prevents the gasket from sticking to the casing and has materially prolonged the average life of gaskets.

William Mulholland is chief engineer of the Los Angeles Bureau of Water Works and Supply. Roderick MacKay is superintendent of irrigations and George Read has charge of the city's meter department.

Volume of Salt in Ocean

The volume of the salt in the ocean, according to the U. S. Geological Survey, is enough to cover the entire surface of the United States to a depth of 8,500 ft.

A Study of the Venturi Flume as a Measuring Device in Open Channels

Experimental Work at the Cornell Hydraulic Laboratory To Obtain Data for More Rational Design of Venturi Flumes—Loss of Head in Venturi Flume Much Less Than in Weir of Same Capacity Range

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EXPERIMENTAL work on the Venturi flume performed by the writers at the hydraulic laboratory of the College of Civil Engineering, Cornell University, indicates that, if properly designed, this device should prove to be of as great value in open channels as is its forerunner, the Venturi meter, in a pipe. It will combine, under field conditions, accuracy at least equal to that of any other open-channel measuring apparatus, together with reliability and small loss of head in the channel. The discharge coefficient in the case of the flume is, however, subject to variations due to the exposed surface, which must be taken careful account of in the design and operation of the instrument.

A Venturi flume consists, fundamentally, of a contraction in the channel having a form roughly similar to a longitudinal section of a Venturi meter. Its transverse section may be rectangular, trapezoidal, triangular, or any other shape. To find the quantity of water flowing in such a device the surface elevation is determined at two points, one up stream from the apparatus and the other in the throat or narrow portion. These elevations are usually determined by means of float gages in separate stilling wells connected to the channel by suitable piping. The difference between the two surface elevations so indicated gives the fall in potential head, most of which has been transformed into velocity head as the stream passes into the narrow throat. From the two elevations the depth, and consequently the cross-sectional areas, at both points are obtainable. With these data and the use of an experimental coefficient, whose value as in the Venturi meter is near unity, the discharge is computed. The Venturi flume has been demonstrated to be a means for measuring water with an accuracy about equal to that of the ordinary weir in practice.

So far as the writers are aware, this device was first mentioned in an article in *Engineering-News*, Aug. 10, 1916, p. 271. It was presented in more detail by V. M. Cone in the *Journal of Agricultural Research*, April 23, 1917. A paper in the *Proceedings* of the American Society of Civil Engineers, Oct.-Nov.-Dec., 1919, by E. W. Lane, treats some phases of the flow of water through Venturi flumes. The Division of Irrigation Investigations, Bureau of Public Roads, U. S. Department of Agriculture, has also been directing considerable experimental work on this device at Fort Colline, Colo., and at Cornell University.

The Venturi flume would probably have a greater first cost than some other devices—a weir, for instance—and an indicating or recording device for it, if direct discharge readings rather than only gage heights were desired, might involve some complications, but in certain respects the Venturi flume has considerable in its favor. It requires very little loss of head to pass water through it, and it is very unlikely to become inaccurate or inoperative by the deposition of silt or floating matter, since, due to the comparatively high throat velocity, any suspended material carried into it will also be carried out. For the latter reason it may very possibly be used successfully for the measurement of the flow of sewage or similar liquids.

The experimental work of the writers was done with the object of obtaining information upon which to base a more rational design of Venturi flumes so that more definite coefficients might apply and so that geometrically similar flumes might be built with greater confidence in their performance.

Two different designs of rectangular Venturi flumes were experimented upon by the authors. Each flume

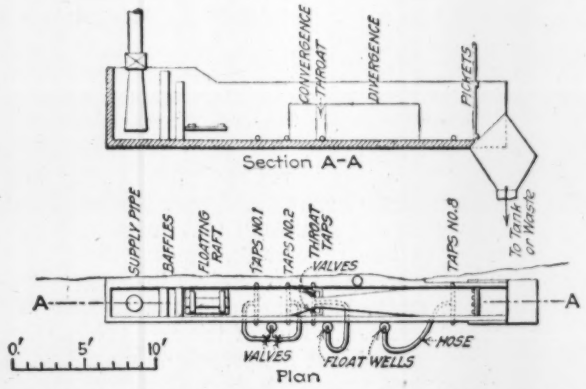


FIG. 1. PLAN AND SECTION OF CANAL AND VENTURI FLUME

had a throat width of 8 in., equal to one-third the width of the channel, and each converged in a distance of three throat widths and diverged in a distance of ten throat widths. The first of these Venturi flumes had a length of throat equal to three throat widths, or 24 in., and the second, a throat length of one throat width, or 8 in. No curved surfaces were employed. The flumes (Figs. 1 and 2) were built up of tongued and grooved dressed cypress with the grain horizontal, the walls of the flume being 30 in. high. At the junction of the wooden flume walls and the concrete channel, at both ends and along the floor, the joint was carefully caulked so that practically no water circulated in the dead space behind the flume walls. All joints, screw heads, and other irregularities were filled with putty to form smooth plane surfaces.

The canal in which the flumes were installed is located in the Hydraulic Laboratory of the College of Civil Engineering of Cornell University. It is a reinforced-concrete channel, rectangular in section, 2 ft. wide by 4 ft. deep, and about 30 ft. long. It is supplied with

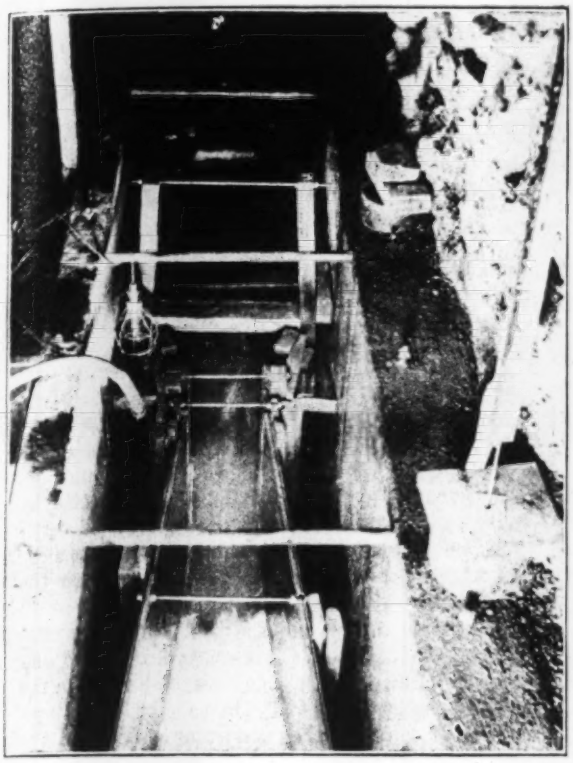


FIG. 2. VIEW OF FLUME LOOKING UP STREAM
About 6 sec.-ft. flowing at depth of 2 ft.

fresh water from Fall Creek through a 10-in. pipe line under about 40-ft. head. A gate valve at the entrance to the canal controls the flow. In order to introduce the water to devices installed further down stream in the canal with as little entrance turbulence as possible, the 10-in. line terminates in a diverging sheet-iron draft tube which helps reduce the entrance velocity. There are also two sets of horizontal baffles and a floating raft.

Discharge measurements were made volumetrically by means of a 400-cu.ft. measuring tank equipped with a diverter by means of which the discharge from the flume could be instantaneously switched from the tank to waste, and vice versa. The volume of water in the tank was determined by means of a carefully calibrated float gage which could be read to tenths of cubic feet. For timing the runs both observed clock time and a two-pen ribbon chronograph, connected to a seconds pendulum, were used.

Every 2 ft. along the canal a pair of opposite, 1-in. pipe openings had been built into the concrete. These entered the sides of the canal normally and horizontally, with inverts level with the floor. The flumes were so placed in the canal that one pair of these openings (taps No. 2 on Fig. 1) came just at the beginning of the convergence. This pair of taps, and the pair 2 ft. further up stream were connected to the gage used for measuring the up-stream head. This arrangement caused taps No. 8, which were used for the down-stream connections, to be approximately 1 ft. 4 in. below the end of the divergence in the case of the 8 x 24-in. throat, and approximately 2 ft. 8 in. for the 8 x 8-in. throat. With the 8 x 24-in. throat, two pairs of gage connections were made to the throat, one pair at a distance of 10⅔ in. down stream from the beginning of the throat, the other pair 16 in., or two-thirds of the throat length, down stream in the throat. The latter pair of connections was used exclusively because a greater Venturi difference (drop in potential head) was thereby shown, and at that time this was thought to be the chief consideration. The 8 x 8-in. throat had but one pair of gage connections, placed 5⅓ in. (two-thirds of the throat length) down stream in the throat. These connections consisted, in both throats, of ¼-in. iron pipe leading to the nearest pair of taps in the concrete. The pipes entered the throat in a direction normal to the throat walls, ended flush, and with edges slightly rounded. Outside of the canal the two taps of each pair used were symmetrically connected, by means of ¼-in. iron pipe fittings, to a tee at a point beneath the center of the canal, from which point ⅜-in. rubber hose led to the gages. In the case of the throat connections valves were placed (Fig. 1) so that either side alone, or both together, could be connected to the gage. The gages consisted of 6-in. iron pipes with cylindrical copper floats provided with radial fins to prevent capillary effects. One-fourth-inch brass rods extended up from the floats and carried pointers which were guided on brass scales. The scales were graduated to hundredths of feet and readings were estimated to thousandths of feet.

SUMMARY OF ORIGINAL DATA, ARRANGED BY SETS

Each set is the average of from two to four independent runs. Sets 68 to 126, for the 8x8-in. throat, show effect of surface disturbance. Column headings are explained in text.

8 x 24-In. Throat

Set	Q	d1	h	h_f	C_f
1	0.335	0.375	0.034	0.007	0.992
2	0.332	0.437	0.023	0.005	0.974
3	0.331	0.529	0.012	0.001	1.067
4	0.331	0.673	0.007	0.001	1.081
5	0.625	0.462	0.110	0.027	1.013
6	0.623	0.517	0.067	0.014	0.994
7	0.623	0.634	0.038	0.005	0.985
8	0.621	0.750	0.024	0.002	1.006
9	0.653	0.997	0.016	0.002	0.948
10	0.655	1.227	0.010	0.002	0.968
11	0.652	1.524	0.006	0.001	1.008
12	0.939	0.589	0.217	0.086	0.987
13	0.938	0.647	0.101	0.015	1.000
14	0.941	0.817	0.051	0.007	0.990
15	0.993	0.982	0.040	0.006	0.954
16	1.012	1.176	0.027	0.004	0.965
17	1.015	1.364	0.020	0.003	0.954
18	1.011	1.543	0.014	0.001	1.000
19	1.007	1.743	0.011	0.002	0.992
20	1.017	1.942	0.008	0.001	1.066
21	1.005	1.981	0.008	0.001	1.022
22	1.651	0.868	0.338	0.248	1.008
23	1.669	0.896	0.242	0.036	0.969
24	1.839	1.059	0.135	0.023	0.994
25	1.831	1.068	0.131	0.024	0.986
26	1.853	1.232	0.090	0.013	0.984
27	1.850	1.453	0.060	0.009	0.973
28	1.851	1.668	0.043	0.006	0.996
29	1.845	1.996	0.0255	0.003	1.052
30	1.838	2.322	0.017	0.002	1.097
31	2.15	1.037	0.402	0.349	1.003
32	2.15	1.044	0.370	0.084	0.981
33	2.15	1.166	0.151	0.023	0.993
34	2.15	1.409	0.086	0.009	1.001
35	2.24	1.638	0.064	0.005	1.018
36	2.24	1.949	0.041	0.002	1.042
37	2.23	2.319	0.026	0.000	1.081
38	3.38	1.413	0.527	0.619	0.981
39	3.38	1.413	0.518	0.308	0.978
40	3.38	1.442	0.427	0.121	0.942
41	3.38	1.501	0.303	0.048	0.940
42	3.38	1.631	0.197	0.029	0.962
43	3.37	1.778	0.149	0.023	0.970
44	3.37	2.007	0.106	0.015	0.979
45	3.36	2.191	0.085	0.011	0.982
46	3.42	2.368	0.072	0.009	0.997
47	4.66	1.744	0.635	0.998	0.983
48	4.66	1.751	0.621	0.433	0.976
49	4.65	1.785	0.522	0.227	0.945
50	4.62	1.882	0.347	0.073	0.935
51	4.64	2.040	0.238	0.041	0.958
52	4.63	2.225	0.178	0.030	0.971
53	4.63	2.385	0.148	0.022	0.970
54	5.99	2.045	0.737	1.315	0.991
55	5.97	2.163	0.505	0.220	0.933
56	5.97	2.406	0.294	0.051	0.946
57	7.41	2.340	0.846	1.602	1.003
58	7.45	2.385	0.750	0.542	0.973

SUMMARY OF ORIGINAL DATA, ARRANGED BY SETS

Each set is the average of from two to four independent runs. Sets 68 to 126, for the 8x8-in. throat, show effect of surface disturbance. Column headings are explained in text.

	8 x 8-In. Throat				
Set	Q	d_1	h	h_f	C_f
1	0.333	0.370	0.029	0.004	0.969
2	0.333	0.413	0.022	0.003	0.972
3	0.334	0.465	0.017	0.003	0.970
4	0.332	0.540	0.012	0.002	0.979
5	0.333	0.609	0.009	0.001	1.004
6	0.332	0.788	0.005	—0.001	1.029
7	0.500	0.416	0.065	0.012	0.952
8	0.498	0.458	0.047	0.008	0.954
9	0.499	0.496	0.038	0.006	0.954
10	0.500	0.559	0.027	0.003	0.982
11	0.499	0.640	0.019	0.001	1.001
12	0.499	0.727	0.013	0.001	1.054
13	0.498	0.782	0.012	0.001	1.019
14	0.500	0.930	0.008	0.000	1.047
15	0.508	1.306	0.005	0.001	0.962
16	0.501	1.294	0.004	0.000	1.064
17	0.795	0.517	0.169	0.047	0.964
18	0.790	0.532	0.134	0.019	0.940
19	0.790	0.569	0.090	0.011	0.950
20	0.792	0.629	0.062	0.008	0.971
21	0.793	0.715	0.042	0.005	0.994
22	0.794	0.845	0.030	0.004	0.979
23	0.790	1.024	0.019	0.003	0.989
24	0.795	1.168	0.014	0.001	1.015
25	0.801	1.379	0.010	0.000	1.026
26	0.803	1.560	0.007	0.001	1.084
27	0.793	1.700	0.005	0.000	1.152
28	1.305	0.720	0.220	0.154	0.978
29	1.305	0.776	0.144	0.019	0.958
30	1.313	0.818	0.113	0.013	0.970
31	1.301	0.949	0.069	0.009	0.983
32	1.312	1.089	0.048	0.005	1.006
33	1.311	1.331	0.030	0.002	1.019
34	1.307	1.655	0.018	0.001	1.039
35	1.312	2.038	0.012	0.002	1.039
36	1.308	2.397	0.009	0.001	1.018
37	2.19	1.008	0.293	0.310	1.004
38	2.21	1.044	0.259	0.086	0.982
39	2.18	1.108	0.178	0.025	0.983
40	2.18	1.260	0.112	0.010	1.000
41	2.18	1.540	0.063	0.002	1.036
42	2.18	1.809	0.038	—0.002	1.112
43	2.18	2.016	0.025	—0.003	1.211
44	2.18	2.237	0.017	—0.004	1.320
45	2.19	2.364	0.014	—0.004	1.384
46	3.33	1.334	0.404	0.513	1.007
47	3.33	1.368	0.355	0.166	0.987
48	3.31	1.500	0.233	0.058	0.963
49	3.30	1.778	0.129	0.014	0.986
50	3.30	2.079	0.080	0.006	1.029
51	3.31	2.427	0.050	0.002	1.098
52	4.52	1.617	0.495	0.723	1.030
53	4.52	1.635	0.467	0.302	1.016
54	4.52	1.734	0.362	0.168	0.979
55	4.52	1.948	0.237	0.069	0.967
56	4.52	2.207	0.159	0.025	0.981
57	4.52	2.417	0.121	0.015	1.005
58	5.83	1.882	0.581	0.980	1.062
59	5.83	1.906	0.554	0.411	1.046
60	5.87	2.038	0.424	0.233	1.002
61	5.86	2.215	0.314	0.143	0.983
62	5.87	2.427	0.235	0.082	0.985
63	7.00	2.094	0.635	1.284	1.084
64	7.01	2.102	0.623	0.542	1.082
65	6.99	2.418	0.378	0.207	0.998
66	8.63	2.393	0.810	1.68	1.098
67	8.67	2.419	0.772	0.636	1.085
68	1.044	2.436	0.0045	.....	1.125
69	1.215	2.426	0.006	.....	1.138
70	1.413	2.428	0.007	.....	1.082
71	1.696	2.431	0.012	.....	1.124
72	1.940	2.427	0.010	.....	1.411
73	2.17	2.429	0.007	.....	1.800
74	2.37	2.426	0.0105	.....	1.678
75	2.63	2.426	0.019	.....	1.398
76	2.87	2.424	0.029	.....	1.237
77	3.13	2.423	0.038	.....	1.183
78	3.39	2.419	0.047	.....	1.161
79	3.62	2.423	0.054	.....	1.071
80	1.023	2.202	0.005	.....	1.157
81	1.218	2.199	0.008	.....	1.091
82	1.428	2.199	0.011	.....	1.092
83	1.667	2.201	0.015	.....	1.093
84	1.916	2.200	0.013	.....	1.350
85	2.15	2.203	0.014	.....	1.459
86	2.39	2.199	0.020	.....	1.361
87	2.62	2.204	0.029	.....	1.244
88	2.84	2.203	0.041	.....	1.141
89	0.922	2.003	0.005	.....	1.146
90	1.122	2.004	0.007	.....	1.178
91	1.329	2.001	0.010	.....	1.171
92	1.558	1.998	0.015	.....	1.124
93	1.821	1.997	0.017	.....	1.234
94	2.06	2.003	0.021	.....	1.262
95	2.29	1.999	0.026	.....	1.258
96	2.51	2.000	0.038	.....	1.149
97	2.75	1.998	0.052	.....	1.091
98	0.814	1.805	0.004	.....	1.252
99	0.988	1.805	0.007	.....	1.149
100	1.177	1.806	0.010	.....	1.148
101	1.406	1.803	0.016	.....	1.084
102	1.666	1.500	0.021	.....	1.135
103	1.907	1.802	0.028	.....	1.129
104	2.15	1.799	0.039	.....	1.083
105	2.37	1.798	0.049	.....	1.074
106	0.570	1.501	0.004	.....	1.053
107	0.733	1.497	0.008	.....	0.963

SUMMARY OF ORIGINAL DATA, ARRANGED BY SETS

Each set is the average of from two to four independent runs. Sets 68 to 126, for the 8x8-in. throat, show effect of surface disturbance. Column headings are explained in text.

	8 x 8-In. Throat				
Set	Q	d_1	h	h_f	C_f
108	0.848	1.500	0.011	.....	0.956
109	1.092	1.503	0.016	.....	1.013
110	1.280	1.501	0.022	.....	1.023
111	1.491	1.508	0.029	.....	1.019
112	1.724	1.499	0.035	.....	1.101
113	2.01	1.499	0.053	.....	1.052
114	2.27	1.499	0.075	.....	1.022
115	2.52	1.499	0.099	.....	1.006
116	0.409	1.000	0.004	.....	1.124
117	0.558	1.005	0.009	.....	1.028
118	0.723	1.000	0.017	.....	0.977
119	0.878	1.002	0.025	.....	0.987
120	1.056	1.000	0.037	.....	0.996
121	1.222	1.001	0.050	.....	1.002
122	1.396	1.001	0.071	.....	0.985
123	1.633	1.004	0.102	.....	0.996
124	1.829	1.000	0.155	.....	0.968
125	2.04	1.005	0.233	.....	0.972
126*	2.13	1.001	0.296	.....	0.987

In order to vary the depth of water in the flume under conditions of fixed discharge, and to avoid the unequal velocity distribution which would have been caused by an ordinary gate or weir, an adjustable system of vertical pickets was arranged downstream in the canal by means of which the water could be backed up to the desired extent.

In the operation of the flume a "run" consisted of a single tank measurement of the discharge, preceded and followed by a reading of each gage. Depending upon the steadiness of the gages, usually three, and sometimes more, runs were made for each condition of flow and the results averaged to make what were termed "sets." These values were used in plotting the curves. The runs varied in length from ½ to 3 min., being never under 1 min. unless limited by the capacity of the tank. In runs of over 1 min. the chronograph was not generally used, as the clock time was found to be sufficiently accurate.

The coefficient referred to previously, and which was used in all computations, is the corrective multiplier which it is necessary to use, as in the Venturi meter in a pipe, in order to obtain the actual discharge from that computed from the gage readings. It is found from the equation derived below. The notation used is as follows:

d_1 = Up-stream depth, the depth at the up-stream gage openings.

d_2 = Throat depth, the depth at the throat gage openings.

d_3 = Down-stream depth, the depth at the down-stream gage openings.

h = Venturi difference, the loss of potential head or drop in surface elevation of the water between the up-stream and throat gage openings.

h_T = Total potential head lost through the flume, the drop in surface elevation of the water between the up-stream and down-stream gage openings.

w_1 = Width of channel at the up-stream gage openings.

w_2 = Throat width at the throat gage openings.

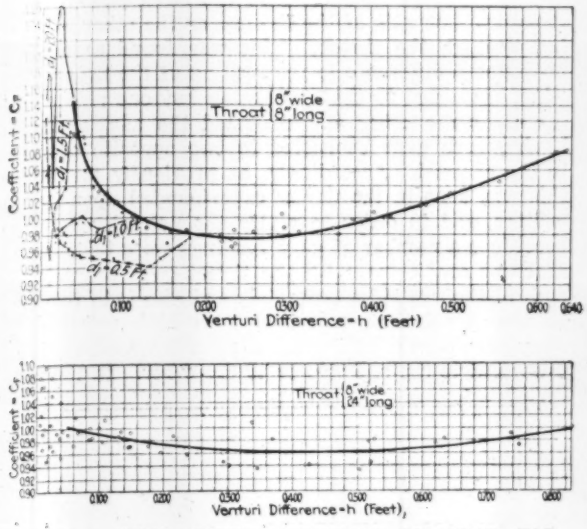
$F_1 = d_1 w_1$

$F_2 = d_2 w_2$

v_1 = Average velocity at the up-stream gage openings in ft. per sec.

v_2 = Average velocity at the throat gage openings in ft. per sec.

Q_A = Actual discharge through the flume in sec.-ft.


Coefficient = C_F
Throat { 8" wide 8" long
d_1 = 0.5 Ft.
d_1 = 1.0 Ft.
d_1 = 2.5 Ft.
Venturi Difference = h (Feet)
Throat { 8" wide 24" long
Venturi Difference = h (Feet)

FIGS. 3 AND 4. VARIATIONS IN COEFFICIENTS FOR 8x8-IN. AND 8x24-IN. VENTURI FLUMES

Q_I = Ideal computed discharge through the flume in sec.-ft.

C_F = Friction or discharge coefficient = $\frac{Q_A}{Q_I}$

The formula for C_F is derived from the following two fundamental equations applying to the steady flow of water:

$$\begin{cases} h = \frac{v_2^2}{2g} - \frac{v_1^2}{2g} & (1) \\ Q = v_1 d_1 w_1 = v_2 d_2 w_2 & (2) \end{cases}$$

From (2): $v_1 = \frac{v_2 d_2 w_2}{d_1 w_1} = v_2 \left(\frac{F_2}{F_1}\right)$

Substituting in (1):

$$h = \frac{v_2^2}{2g} - \frac{v_2^2}{2g}\left(\frac{F_2}{F_1}\right)^2 = \frac{v_2^2}{2g}\left[1 - \left(\frac{F_2}{F_1}\right)^2\right]$$

$$v_2^2 = \frac{2gh}{1 - \left(\frac{F_2}{F_1}\right)^2}; \quad v_2 = \sqrt{\frac{2gh}{1 - \left(\frac{F_2}{F_1}\right)^2}}$$

Substituting in (2):

$$Q = F_2\sqrt{2gh}\sqrt{\frac{1}{1 - \left(\frac{F_2}{F_1}\right)^2}} = Q_I$$

$C_F = \frac{Q_A}{Q_I}$, therefore, is equal to

$$\frac{Q_A}{F_2\sqrt{2gh}\sqrt{\frac{1}{1 - \left(\frac{F_2}{F_1}\right)^2}}}$$

Since the quantity $\sqrt{\frac{1}{1 - \left(\frac{F_2}{F_1}\right)^2}}$ is determinable by direct measurements it has been termed C_M, the meter or flume coefficient.

In order to show the variation of the coefficient, C_F, of the flumes for changes in the conditions of flow the curves shown in Figs. 3 and 4 were plotted, having C_F as ordinates and h as abscissas. As will be noted from the plottings, no differentiation is made in the case of the 8 x 24-in. throat for different up-stream depths, as there seemed to be no difference with different depths even for low values of h, and in the case of both throats, especially the 8 x 8-in., all points appear to define a definite curve above certain values of h.

While making runs on the 8 x 8-in. throat with low Venturi differences and comparatively great depths, the peculiar phenomenon shown most clearly by Fig. 5 was observed: that is, a decrease in h for increased Q_A under certain conditions. Upon careful observation of the surface appearance under these conditions it was concluded that this variation was entirely due to the presence of waves of various types superimposed on the otherwise natural surface of the water flowing through the throat, these existing on account of the tendency under some conditions for the tail water to run back into the low throat. This affected the throat gage and varied the observed values of h and d_1 from their otherwise proper values. Of course this variation causes a corresponding irregularity in the coefficient C_F. It is seen from the curves that as the depth decreases or the Venturi difference increases, the effects due to the waves are reduced.

This is principally due to the fact that the increased throat velocity prevents the tail water from encroaching on the throat to as great an extent as with small Venturi differences. It will also be noted that the variation of the coefficient, Figs. 3 and 4, at low Venturi differences is not nearly so great in the case of the 8 x 24-in. throat, where the throat gage openings were three times as far from the down-stream end of the throat as in the 8 x 8-in. throat, where the waves could more readily run back from the divergence to a point opposite the gage openings. It is quite probable that variation in the coefficient, possibly accounting for a considerable part of that shown for the 8 x 24-in. throat, is due to the increased percentage of error in the determination of h, as that quantity decreases.

For these reasons the exact location of the gage openings in the throat is of great importance. A change in length of throat, or position of openings, or both, may greatly affect the variation in the coefficient by removing the openings from the influences of the surface disturbances under certain conditions, and possibly subjecting them to these influences under different conditions. It seems probable that by removing the throat gage openings to a greater distance than one-third the throat length (with throat length equal to the throat width) from the down-stream end of the throat, either by placing them at the midpoint of a throat of length equal to its width or by increasing the length of the throat to, say, one and one-half or two times its width, and leaving the openings at the two-thirds point, the variations in the coefficient might be greatly reduced. This is confirmed by the comparative absence of these variations in the 8 x 24-in. throat.

It is seen that for rough measurements of discharge, provided extreme values of h are not employed (with flumes the size and design of those experimented with by the writers h should be kept between 0.1 ft. and 0.4 ft. approximately), the use of a constant coefficient of about 0.98-1.00, as with the Venturi meter in a pipe, will give results satisfactory for most purposes within 5 per cent error.

The actual loss of head involved in the use of the Venturi flume occurs chiefly during the reconversion of velocity to potential head in the diverging portion of the flume, and is, of course, greater than in the pipe Venturi meter, due to the disturbances incident to an exposed surface. With a constant up-stream depth the loss of head increases as the discharge increases, and with a constant discharge it decreases as the up-stream depth increases. With a given discharge the Venturi difference increases as the backwater and depth are decreased until a more or less definite point of free discharge is reached, beyond which point the conditions in the throat and up-stream from the flume are no longer changed by a removal of backwater, the loss of head alone being increased. The value of h, under these conditions, is at its maximum for the given discharge,

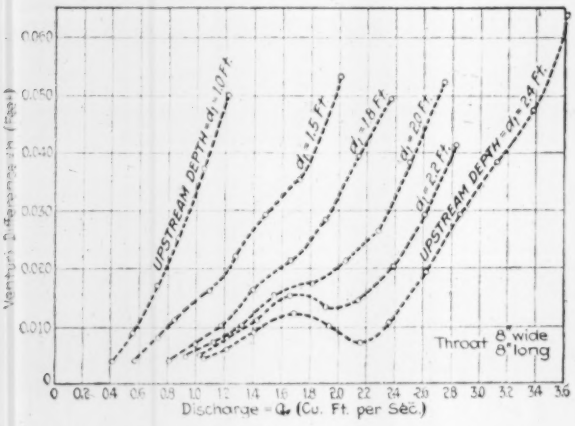

Venturi Difference in Feet
UPSTREAM DEPTH = d_1 = 1.0 Ft.
d_1 = 1.5 Ft.
d_1 = 1.8 Ft.
d_1 = 2.0 Ft.
d_1 = 2.2 Ft.
UPSTREAM DEPTH = d_1 = 2.4 Ft.
Throat 8" wide 8" long
Discharge = Q (Cu. Ft. per Sec.)

FIG. 5. IRREGULAR VARIATION IN INDICATED VENTURI DIFFERENCE DUE TO SUPERIMPOSED WAVE EFFECTS IN VENTURI FLUME

and thus no useful purpose is served by exceeding the loss of head occurring when that point is reached, unless it is desired to use the flume as a kind of orifice. In Fig. 6 is shown a curve for each of the two flumes experimented upon which gives the loss of head occurring at the point of maximum Venturi difference for each discharge. The value of the loss of head thus shown for any particular discharge represents the loss of head necessary to discharge that quantity of water through the flume with the maximum possible value of h and the minimum possible up-stream depth, d_1. This value of h_r (loss of head) may be decreased, and still discharge the same quantity of water, by increasing the depth, incidentally decreasing the Venturi difference. In order to determine the minimum possible value of d_1 for a given discharge, the rating curves, discussed later, should be used. If it is desired to exceed the discharge thus determined for any particular up-stream depth the throat width must be increased. It is seen that with an 8-in. throat width the maximum necessary loss of head in tenths of feet is numerically about equal to the discharge in cubic feet per second.

In the already mentioned Cornell University work under the Irrigation Investigations Division, Bureau of Public Roads, U. S. Department of Agriculture, all of the Venturi flumes used were built with an angle of divergence equal to the writers' angle of convergence, 1:3, and in these flumes a phenomenon was observed very similar to that described by Mr. Lane for channel contractions (p. 773 in the *Proceedings* referred to above), namely, a swinging of the main thread of the stream to one side of the channel or the other in passing through the throat. This was found to cause a pronounced difference in the reading of the throat gage when connected to the opening on but one side of the throat or the other and indicated the advisability of having each gage connected to two opposite openings in the channel. Accordingly, as previously mentioned, this was done in the flumes experimented upon by the writers, and in order to verify the necessity for such procedure a number of gage readings were taken under different conditions, with the throat gage connected to each of the two sides separately and also both together. It was found that, especially with high velocities of flow, there was a difference between the readings when connected to the one side or to the other. In the small

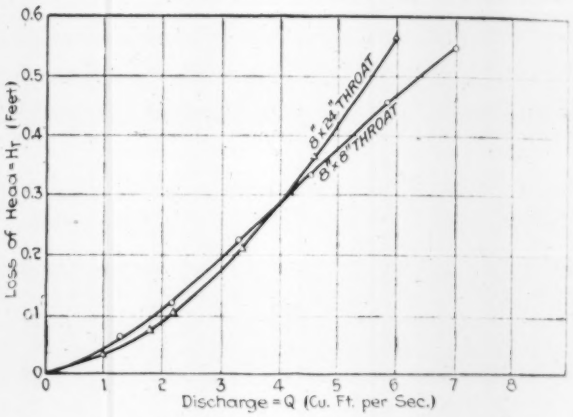


FIG. 6. LOSS OF HEAD AT MAXIMUM VENTURI DIFFERENCE FOR EACH DISCHARGE

flumes used this difference amounted at times to several hundredths of a foot. It was also found that when connected to both sides of the channel at once the reading was very nearly, if not quite, equal to the mean of the readings connected to each side separately. The difference in the two sides did not, however, appear to be due to a more or less optional shifting of the main thread of the stream, as in the two cases mentioned above, but seemed to be due to some minor, imperceptible lack of symmetry in the flumes, as the high and low sides could not be interchanged. The reason for the thread of the stream not shifting in the writers' flumes probably was due to the more gradual divergence and indicates an advantage in such design.

As has been previously mentioned, provision was made for connecting the up-stream gage to either one of two pairs of gage openings, one of these pairs being located just at the beginning of the convergence and the other 2 ft. further up stream. For practically all runs the down-stream one of these two pairs of openings was used but the up-stream pair was frequently connected to the gage (meanwhile disconnecting the other pair) and the difference in reading, if any, noted. By means of a number of readings taken while connected to one or the other of these two pairs of openings under various conditions of flow, with no Venturi flume installed in the canal, it was ascertained that the presence of the Venturi flume made no difference in the relation between readings obtained with these two pairs of openings. It may therefore be concluded that the openings into the channel connecting with the up-stream gage may be

located at any point convenient, down to the actual point of beginning of the convergence. Practice in this regard, however, should conform to that followed in the flume, the calibration for which is used. Of course, in no case should the distance up-stream be great enough to involve appreciable loss of head by friction in the channel.

The conclusions arrived at by the writers may be stated briefly as follows:

1. The coefficient of the Venturi flume for any particular condition of flow within rather wide limits is a fixed determinable quantity about unity. With the flumes experimented upon, however, the value of the coefficient varied over a range of possibly 10 per cent with varied conditions of flow, most of this variation being apparently due to surface phenomena, waves, etc., the effect of which could be controlled by the design of the flume so as to obtain a more definite coefficient.

2. The maximum loss of head necessary in the use of the Venturi flume is very small compared to that lost with other measuring devices under similar conditions. A weir with the same range of capacity would probably involve at least five or six times as much loss of head.

3. The necessity for connecting each of the gage wells to a pair of opposite gage openings in the channel was verified.

4. The exact location of the up-stream gage openings was found to be immaterial as long as they were placed up stream from, and fairly close to, the beginning of the convergence.

The determination of the discharge of the Venturi flume, from the readings of the up-stream and the throat gages, is slightly more involved than in the case of the Venturi meter in a pipe, since, besides the Venturi difference, the depth must also be taken into account. For this reason an automatic recording device, such as commonly used with the Venturi meter, while undoubtedly practical, would probably be more complicated.

For obtaining the discharge from the gage readings without recourse to the formula, rating curves were constructed from the flumes experimented upon. These were plotted on logarithmically ruled paper with up-stream depths as ordinates and Venturi differences abscissas. Interpolation may be made between the curves of constant discharge on this plotting. The form of these rating curves was suggested to the writers by Prof. E. W. Schoder, of Cornell University. A table, such as the one presented by Mr. Cone in the article already mentioned, may also be constructed giving discharges for various values of depth and Venturi difference.

The writers wish to acknowledge their indebtedness to Prof. E. W. Schoder, in charge of the Hydraulic Laboratory at Cornell, for his suggestions and advice.

Vitrified Brick Production

With the removal of Government restrictions on road building the output of vitrified brick or block in 1919 increased to 485,139,000, 20 per cent higher than the 1918 output, though below the normal, having been little more than half the average reached during the preceding ten years. The estimated average price per thousand in 1919, -23.11, was the highest ever recorded, says a recent press bulletin published by the U. S. Geological Survey.

Sewerage and Water Improvements at Decatur, Illinois

Contracts for Intercepting Sewers and Storage Dam To Clean and Regulate Sangamon River— Sewage Treatment Proposed

AFTER six years of investigation and a series of sewage-treatment experiments the first two of several large contracts for intercepting sewers and sewage treatment have been let by the Sanitary District of Decatur, Ill., and work has actually started. At the same time the City of Decatur has entered into a cost-plus contract for the construction of a storage dam for additional water supply which is also related to the sewage disposal problem. These improvements for cleaning and regulating the flow of the Sangamon River are estimated to cost over $2,000,000.

Decatur has population of about 50,000. Its sewage flow is about 5,500,000 gal. per 24 hours. Included in this is about 1,250,000 gal. of strong industrial sewage from a starch factory, exclusive of condenser water. There is also included the sewage and wastes from a creamery, packing house and gas-works. The city sewage, without the industrial sewage, has a biological oxygen consumed value of 171 p.p.m., which is increased by the industrial sewage to about 400 p.p.m. The minimum required volume of diluting water for the latter figure is about 40. Sewage treatment is required because during three or four months in the summer the entire flow of the Sangamon River is used for the water supply of the city and is subsequently turned back into the stream as sewage. This creates an open sewer passing by the city and continuing in a lessening degree for twenty miles below.

Even with the use of the whole dry-weather flow the river is insufficient for the water supply needs of the city and consequently a large storage dam is under construction. This will afford water for sewage dilution also.

Sewage-Treatment Experiments

A number of special tests of sewage-treatment processes have been made. A testing station comprising an Imhoff tank and sprinkling filter with appurtenances was built in 1914 and operated during 1914, 1915 and 1917. During 1917 small-scale tests were made of the activated-sludge process on the mixed sewage, and in 1919 a testing station was built and operated to try the activated-sludge process on the crude starch works sewage. It was found that the activated-sludge process is applicable to the mixture of city and starch-works sewage, but not to the starch-works sewage alone. The tests also showed that Imhoff tanks removed 50 to 60 per cent of the suspended solids from the mixed sewage, and that sprinkling filters operating with settled sewage at a maximum rate of 1,000,000 gal. per acre per 24 hours would produce a 90 per cent stable effluent. A decision has not yet been made as to the type of treatment that will be adopted.

In the meantime two of the three contracts for intercepting sewers are under way. The first contract (let in October, 1919) is for 35,000 cu.yd. of earth embankment at 65c. per cu.yd. The second is for about 7,000 ft. of 5- and 6-ft. sewer in open cut and tunnel (let in April, 1920) for $285,000 the principal bid unit prices being as follows:

6-ft. sewer, open cut, per lin ft	$33 00
Tunnel, per lin ft	45 25
5-ft. sewer open cut, per lin ft	22 10
Tunnel, per lin ft	40 25
Standard manholes, each	200 00
Reinforcing steel, per lb	06
Earth embankment, per cu yd	1 00

The intercepting sewer starts at the main city sewer farthest upstream, parallels the river, intercepts four existing main sewers and extends about 14,000 ft. to the sewage-works site, where the elevation of the sewer invert is about 19 ft., about the normal water level in the river, so that interference by floods and pumping to the treatment plant are avoided. The first half of the sewer is 6 ft. in diameter, designed to carry some storm sewage to an overflow located below the built-up portion of the city. The remaining portion is to be 5 ft. in diameter, designed to carry three times the estimated 1960 dry weather sewage flow. Special interceptors have been designed at the various main sewers. The sewers will be partly of segmental block and partly of concrete. The sewerage work is being carried out by the Decatur Sanitary District under the general direction of Pearse, Greeley and Hansen, consulting engineers, with P. T. Hicks, district engineer, in direct charge.

Water-Supply and River Regulating Dam

To provide an ample water supply for the rapidly increasing domestic and industrial needs of the city a storage dam is under construction. The dam consists of a 500-ft. concrete spillway section 28½ ft. high above the river bed, flanked by 1,100 ft. of earth embankment, the top of the latter rising 13 ft. above the spillway crest. A moveable crest of special design is included, by which an additional 2 ft. of storage can be secured, giving a total storage capacity of about 9,000,000,000 gal. and an estimated dry-weather yield of about 40,000,000 gal. per 24 hours. This will provide some additional water during the next few years for flushing out the river during dry-weather periods, thus assisting the sewerage program. The 13 ft. of free board between the crest and embankment levels will pass, with an ample margin of safety, the maximum flood of record in 1913, which was 21,500 sec.-ft. equivalent to 25 sec.-ft. per square mile on a tributary area of 862 sq.mi.

Borings at the site of the dam show a reddish brown clay for the first 10 ft., and then alternately layers of fine and coarse sand with pockets of gravel and clay. At a depth of 30 to 45 ft. is a layer of sand and clay 8 ft. thick, dipping slightly from south to north, and below this depth more sand.

To prevent disintegrating percolation the design provides a sheet piling cut off under the entire length of the dam, varying in depth below the dam up to a maximum of 30 ft. The spillway section has a heavy concrete apron extending 32 ft. downstream and a light apron extending 40 ft. upstream. The earth sections will be tied into the sheet piling with clay puddle. Bearing piles will be driven under the spillway section on 3½ ft. centers, with pressures limited to 1½ tons per sq.ft. Two 9 x 14-ft. flood gates are provided with all the necessary footings for two hydro-electric units.

The dam, exclusive of land and the cost of relocating bridges and highways, is estimated to cost $800,000. A cost-plus contract has been let which fixes a maximum price of $975,000 and a base price of $700,000, both computed on the engineers' estimate of quantities. If the actual cost of the work is $700,000 the contractor will receive a fee of 10 per cent plus $20,000 for his plant, or the total of $90,000. If the cost exceeds $700,000 the fee of 10 per cent is reduced by 20 per cent of the over-run, down to a minimum of $35,000. If the cost is less than $700,000 the contractor's fee of ten per cent will be increased by 20 per cent of the under-run. The payment of $20,000 for plant is made in either case and the contractor agrees that the total cost to the city, under the engineers' estimate of quantities, will not exceed $975,000. If these quantities change the engineer will base prices accordingly.

The contractors for the dam are L. N. Cope & Son of Decatur, and the work is under the direction of Pearse, Greeley and Hansen, consulting engineers, with F. Albert Holmes as resident engineer. W. J. Collins is city engineer.

Design Elements of Various Imhoff Tanks

COMPARISONS of elements used in the design of Imhoff tanks at different places in the country indicate a wide diversity of opinion as to several factors. The following table is taken from a report by Pearse & Greeley, consulting engineers, Chicago, on the sewage problem of Decatur, Ill. (See preceding article.)

The populations for which the tanks were designed range from 10,000 at one of the Rochester plants to 300,000 at Philadelphia. The range in settling periods allowed is from 1.33 hours at the larger Rochester plant to 3 gal. at several places. The greatest liquid depth is 35 ft. at the smaller Rochester works and the smallest is 13.5 ft. in tank finally built at Schenectady. Sludge storage capacity provision ranges from 0.43 ft. at Dallas to the larger Rochester plant.

SEWAGE TREATMENT ELEMENTS OF IMHOFF TANKS IN CITIES OF OVER 25,000 POPULATION

City	Population in Thousands: Connected to Sewers	Population in Thousands: Basis of Design	Settling Period Hours: Present Flow	Settling Period Hours: Basis of Design	Total Liquid Depth Ft. In.	Sludge Storage Cu.Ft. per Capita: Connected to Sewer	Sludge Storage Cu.Ft. per Capita: Basis of Design	Gas Vent Area, per Cent Total Tank Surface	Sewerage
Fitchburg	(1) 37	55	6 8	3 0	25—2	1 94	1 3	15 0	Comb.
Albany	101	150		3 0	27—2½	....	1 41	4 2	Comb.
Schenectady (a)		120			21—4½	....	0 71	....	Sep.
(b)	65	120	3 18	....	13—5	....	0 75	....	Sep.
(c)	105		2 3	....	....	0 66	....	....	Sep.
Rochester (d)	240	200	1 07	1 33	34—4	2 65	3 18	26 8	Comb.
(e)	5	10	3 67	2 to 1 2	35—0	3 6	1 8	10 1	Sep.
Dallas	120	135	....	3 0	....	....	0 43	12 5	Sep.
Columbus	220	250	3 1	2 46 max.	25—8	1 62	1 25	9 0	Comb.
Akron		150	....	2 0	23—9	....	0 75	4 6	Sep.
Atlanta (f)		52	....	3 0	24—9	....	1 73	4 8	Sep.
Philadelphia		300	....	3 0	27—0	....	1 78	6 2	
Decatur (g)	43	60	....	2 0	22—3½	....	1 24	20 0	Comb.

(1) In 1918.—(a) Original design. (b) Final design as built. (c) On basis of population 105,000 served and flow of 8,000,000 gal. per 24 hours. (d) Irondequoit. (e) Brighton. (f) Peachtree Creek. (g) Basis used for estimates.

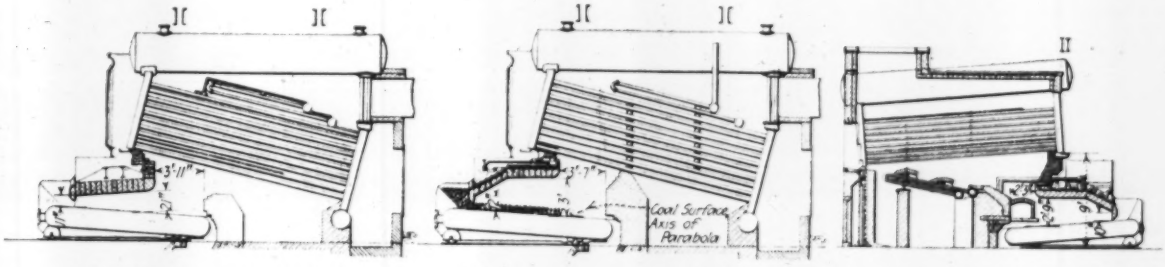
Economies in Pumping Station Operation at St. Louis

Review of Coal Saving Efforts and Results in the Past Five Years—Boiler Efficiencies Increased by Changes in Grate Settings and Baffles—Pump Duties Raised by Using Superheated Steam

Abstract of a paper by L. A. Day, Engineer-in-charge, Operating Section, Water Division, St. Louis, Mo. Read before the American Water Works Association, June, 1920.

OWING to the rapid increase in the cost of coal it became imperative on the part of the mechanical engineers of the St. Louis Water Department to make a thorough investigation of the heat losses existing in our respective pumping plants with a view to reducing the losses to the lowest possible minimum. When it is considered that the coal makes up probably 40 per cent of the total pumping cost and that in the average pumping plants throughout the country not more than 10 per cent of the heat value in coal is utilized, it is easy to see that the more economical use of coal is highly profitable. The object of this paper is to present an account of the pumping station economies effected at St. Louis during the past five years.

According to our experience, the chain-grate type of stoker is best suited for burning the low grade clinkering coals, such as are found in the Illinois coal fields within a radius of 25 miles from St. Louis. This type of stoker is capable of meeting any peak load up to 100 per cent above normal boiler rating. It is simple in construction, easy to repair, it can be operated under all load conditions with natural draft, thereby greatly simplifying the boiler room equipment, and can be operated efficiently on light loads and overloads. It's first cost is about half of that of the forced draft underfeed type. A ratio of 1 sq.ft. of grate surface to 48 sq.ft. of boiler heating surface has given the best results, considering our loads and coals. The coal is 2-in. Southern Illinois screenings having an average heat value of 10,300 B.t.u., with from 20 to 25 per cent ash.



Old Setting at Chain of Rocks — New Setting at Chain of Rocks — New Boilers at Baden Station

FIGS. 1 TO 3. BOILER SETTINGS AT PUMPING STATIONS OF WATER-WORKS OF ST. LOUIS, MISSOURI

In addition to the proper size grate our experience shows that a properly designed furnace arch, and a combustion chamber with sufficient volume to allow complete combustion, will add greatly to the efficiency and capacity of the boilers.

The first chain-grate stokers we installed were at the Chain of Rocks plant in 1914. The stokers were placed under six National water tube boilers, each of 360 hp., and two O'Brien water tube boilers, each of 250 hp. capacity. The boilers were set 7 ft. from the floor, and the arches were set 11 in. from the grate at the front and 22 in. from the grate at the rear, the arch being 6-ft. 5-in. long. The original arch was set according to the design of the stoker contractor. The boilers were arranged with horizontal baffles, the lower baffle being placed on the second row of tubes. The average boiler efficiency under operating conditions with this setting was approximately 58 per cent and it was difficult to obtain an overload of 25 per cent.

Investigations were started with a view of increasing the boiler efficiency and capacity. We have found that a stoker arch to function properly should be set high enough over the grate to allow the volatile gases to be distilled off without being crowded under the arch; also the shape of the arch should be such as to allow the heat from the bridge wall to be focused on the coal as it enters the furnace; this is necessary to start combustion in as short a time after the coal leaves the feed gate as possible so that every available foot of grate surface is utilized for burning coal. By referring to Fig. 1, which shows the original arch, it will be apparent that from the standpoint of obtaining a large liberating volume under the arch and an efficient shape of the roof so as to obtain the maximum benefits of heat reflection coming from the bridge wall, this arch did not function properly. It did not permit a concentration of heat at a point where a maximum concentration is desired, namely: at the point of ignition. These objectionable features have been overcome by the new design of arch shown by Fig. 2.

In this setting, the distance from the floor to the front water leg remains 7-ft., being determined by the original setting of the boiler. The arches are set 12-in. from the grate at the front end, rise rapidly to a hip, and are 36 in. high at the rear. The length of the arch is 6½ ft. This arch has a better concentration of heat rays near the feed gate, the rays being reflected from the bridge wall, than the one shown by Fig 1, due to our obtaining a contour which approximates the curve of a parabola, in which curve all reflected heat rays would concentrate at the focus.

Comparative tests made before and after the change in the arch shape showed: With the old type of arch, on a capacity test run by the stoker contractor, an evaporation of 15,770 lb. of steam per hour was main-

tained for 10 hours. With the new style arch an evaporation of 17,140 lb. of steam per hour was generated for five hours. The former represents an overload of 38 per cent while the latter represents an overload of 60 per cent. At the same time the average boiler efficiency was increased from 58 to 63 per cent, or a gain in efficiency of approximately 9 per cent. After all the boilers have been equipped with the new arch, it is estimated that the saving in annual coal cost will amount to about $5000 at this station.

A similar improvement in capacity and efficiency was made at the Bissell's Point Station. The boilers here

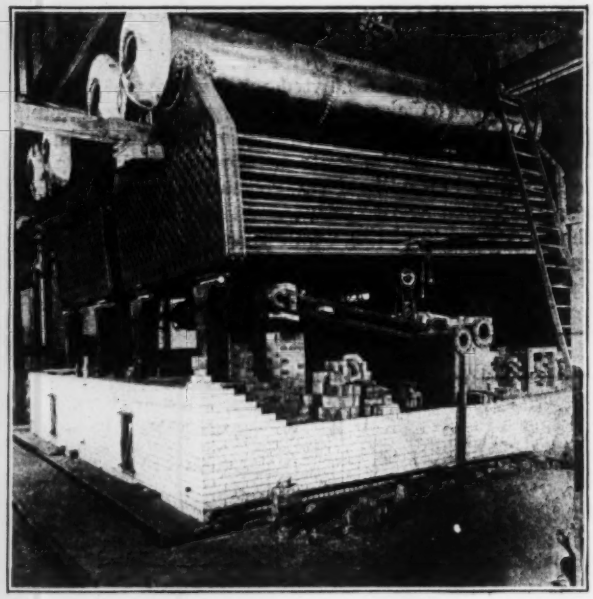


FIG. 4. VIEW OF SETTING OF BOILERS AT BADEN STATION, SHOWING SUPERHEATERS IN COMBUSTION CHAMBER

are set with the front water leg 6½ ft. above the floor line. The original arches were sprung transversely across the grate, 9 in. above the grate at the hip, rising to 18 in. above the grate at the center. Longitudinally, the arch was parallel to the grate. This type of arch (that is, in respect to the low height above the grate) was the common practice among chain-grate stoker builders up to within but a few years past. The arch was removed and replaced with a new type of flat arch, which is 12 to 13 in. above the grate at the feed gate and rises straight, without a hip, to 30 in. above the grate at the rear end. The length is 7 ft. It was not possible to construct a hipped arch at this station because of the limitation of the low setting. However, a good saving was effected for the reason that prior to the change in arch design, it was only possible to burn crushed egg or lump coal at this station, due to the low arches, which did not effect a proper ignition with the lower grades of screenings. The new designed arch has resulted in our being able to burn the lower grades of screenings successfully, and obtain the same evaporation per pound of coal with screenings as with the crushed egg or lump coals, thereby resulting in a saving in the price of coal of about 18 per cent. This 18 per cent saving in the price of coal, when applied to our last year's coal cost at this station, amounts to an annual saving in coal cost of about $10,000. After the boilers at this station were equipped with the new type arch, the average overall rating of the boiler room rose from 90 per cent to 115 per cent, even with the use of a lower grade of coal.

Although we realized, after the new arch was designed, that the setting was not perfect, the boilers being too low, yet even with the low setting the arch has given the improvement in capacity and efficiency mentioned above, permitting one boiler to be taken off the line.

The experiences outlined led us to adopt, in the installation of new boilers at the Baden plant, a setting in which we have embodied a construction which we believe eliminates all objectionable features found by previous experience (Fig. 3). In this setting the arch is similar to that of the new arch for the Chain of Rocks Station, the distance at the feed gate above the grate is 10 in., rising rapidly to a hip, and is 34 in. above the grate at the rear. The length of the arch is 7 ft. The height of the front water leg above the floor is 9 ft., this height providing a larger combustion chamber than in the previous settings, thereby obtaining a more thorough mixing of the gases and oxygen and providing a relatively longer gas travel, all of which is necessary for the efficient burning of coal at high rates of combustion. The evaporation at this station averages 6½ lb. of water per pound of coal at a boiler efficiency of 66 per cent, and comparing this performance with that of the other stations, when the old type of settings prevailed, shows a saving of about 13.8 per cent in coal.

As has been previously stated, the over-all boiler efficiency of the other two stations is 63 per cent with the improved arches while that at the Baden station, with practically the same style arch as was adopted at the other stations, shows an over-all boiler efficiency of 66 per cent. This increase of 3 per cent in efficiency, or a gain of 4.8 per cent, may be attributed to the higher boiler setting, namely 9 ft. instead of 7 ft. which prevails at the other two stations. In other words, by setting the boilers 2 ft. higher at the Baden station, we show a gain of 4.8 per cent in over-all boiler efficiency, and this gain when computed on the annual cost of coal at this station, amounts to $3,000 annually.

An operating over-all boiler efficiency of 66 per cent, using Southern Illinois screenings of 10,000 b.t.u. per pound, and meeting a variable daily load, may be considered as good as can be expected from this type of boiler room installation.

The cost of rebuilding the arches at the Chain of Rocks and Bissell's Point stations amounted to about $300 per arch or a total of $4,200, while the saving in coal effected by these changes amounts to approximately $15,000 a year. The entire work of rebuilding the arches was paid for in 3½ months.

The above mentioned gains are principally due to the improvement in furnace design, but part of the saving in coal must be credited to improvements made in our boiler baffling.

Boiler baffling should be so placed as to force the gases into contact with all parts of the tube bank. In the older Heine type of settings at our plants, the lower baffle was made up of box tile on the lower row

tubes and the upper baffle was 13 tubes above on the row of tubes. The opening in the lower baffle was some cases as much as 60 in. from the rear water leg. The path of the gases in this type of boiler was diagonally upward through the tubes, leaving the rear water leg and the tube ends near it untouched by the hottest gases, and leaving a dead triangular pocket at the bottom of the front water leg.

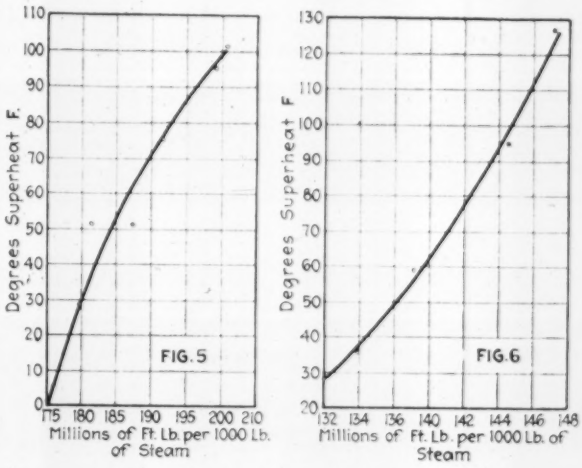
By eliminating the box tile on the lower row of tubes and placing a specially designed tile on the third row of tubes, and also reducing the opening in the lower baffle from 60 to 42 in., we reduced the flue temperature from an average of 650° F. to 550° F.

It will be apparent from Fig. 3 that the velocity of the gases is higher through the tubes, thereby reducing the insulating effect of the film of idle gas around the tubes and resulting in a better heat absorption. It will also be apparent that the bottom rows of tubes are now exposed to the radiant heat of the flames; thus by raising the baffle tile onto the third row of tubes, the gases are crowded into more intimate contact with the tubes, dead pockets in the passes are destroyed, and the lower row of tubes, by absorbing the radiant heat of the flames, tends to lower the temperature of the surrounding walls of the combustion chamber, which in turn tends to increase the life of the setting.

When it is remembered that roughly there is a gain of 1 per cent in boiler efficiency for every 25°F. reduction in flue temperature, it will be seen that there was an approximate gain of 4 per cent in efficiency for the 100°F. drop just mentioned, a gain effected by merely placing the boiler baffling in a better location and at a negligibly small cost.

Simultaneously with the installation of chain-grate stokers, superheaters were installed in our boiler settings (Fig. 4). For determining the size of superheaters, accurate gas temperatures were taken at the place where the superheaters were to be located, and steam, load, and firing conditions noted simultaneously as an aid to the manufacturer of the superheater arriving at its proper size. In the case of horizontally baffled boilers, our superheaters are located in the combustion chambers back of the bridge wall. In the vertically baffled boilers, the superheaters are located under the shell between the first and second pass. Although the location behind the bridge wall is apparently a severe location, yet it has been our experience that if the superheaters are not within the direct path of the flame they show no effects of the heat and promise a long life. The advantages of the location in the combustion chambers are a smaller superheater and greater accessibility.

The use of superheated steam at all of our plants has proven to be one of the greatest factors in increasing the efficiency of the engine rooms. Superheated steam in the cylinder of a steam engine transfers heat to the cylinder walls, but instead of condensation occurring on contact as with saturated steam, the superheat must first be withdrawn. Superheated steam maintains a higher cylinder wall temperature and if superheating is carried far enough, condensation can be delayed until after cutoff and even until expansion is partly completed. Also the specific volume of superheated steam is greater than that of saturated steam and this increase in specific volume, the pressure being constant, diminishes the weight of steam to the engine, and has



FIGS. 5 AND 6. PUMP DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT AT ST. LOUIS

an influence on the economy gain, as has also the lower thermal conductivity of superheated in comparison with saturated steam.

The Water Division has made tests on the effects of superheated steam on triple expansion and on compound pumping engines. The triple-expansion engines, which pump against 85 to 125 lb. pressure, and whose capacities vary from 15 to 20 m.g.d., showed a saving for various degrees of superheat as represented by the curve, Fig. 5. The steam saving for 100 degrees superheat amounted to 12.1 per cent, while the saving in coal amounted to 7.5 per cent. The low service compound pumping engines, which pump against a maximum head of 65 ft. or about 28 lb. pressure, and whose nominal capacity is 30 m.g.d. showed a saving for various degrees of superheat as represented by Fig 6. The steam saving for 100 degrees superheat amounted to 17.3 per cent, while the saving in coal amounted to 13.2 per cent.

The saving in coal due to the introduction of superheated steam at the Chain of Rocks station has been sufficient to pay for the superheaters in about 3½ years. The life of a superheater, when the elements are not exposed to the direct flame, should be equal to the life of the boilers.

It is commonly accepted that the degree of superheat for the usual equipment of engines and pumps is limited by a total temperature of 500°F., especially when cast-iron fittings are used. The Water Department has resorted to the use of cast-steel fittings and valves on all new pipe work. The new pipe was put in only to meet the total temperatures of the superheated steam which we intended to use, but also to insure more reliable service in all of our pipe lines than cast-iron fittings and valves would give. In one of our plants the original extra heavy cast-iron fittings have given excellent service with a total temperature of as high as 500°F. These fittings have been in service some five years under superheated steam conditions without showing any apparent signs of weakness.

When the compound pumping engine was originally installed 25 years ago, it developed a duty of 118,000,000 ft.-lb. per 1,000 lb. of saturated steam, no superheat being used. The pumping engines at this station were all bought on the bonus and forfeiture basis which naturally led the contractor to make every effort toward

obtaining the highest duty possible. The Water Department, however, in running the duty tests with variable degrees of superheat, made no attempt whatever to increase the economy of the pumping unit before the test was run—by increasing the vacuum, repacking the plungers, renewing pump valves, inspecting valves and pistons, etc. In other words, the test was made on a pump running under every day plant conditions and even with a superheat of on'y 28°, which is the lowest we could obtain, the pump developed a duty of 132,000,000 ft.-lb. per pounds of steam, which is a saving of 11.9 per cent in steam consumption over that of the original duty test with saturated steam, where the duty obtained was 118,000,000 ft.-lb. per 1,000 lb. of steam. This is a very creditable showing for a pump that has been in service for 25 years.

As previously mentioned we expected a better saving by the use of superheated steam on our compound low-service pumping engines than on the high-service triple-expansion engines, for the reason that a compound pumping engine of the usual cylinder proportions is not as economical as a triple-expansion pumping engine, due to a greater heat drop in each cylinder causing a greater cylinder condensation, and as superheated steam specifically functions to prevent cylinder condensation, it follows that its greatest virtue will be manifested in the less economical engine.

There seems to be, to the writer's knowledge, a prevailing impression in a great many water-wo-ks plants, that the use of superheated steam, with its consequent economies, is offset by difficulties with lubrication. This contention is not borne out by our experience. In lubricating engines using superheated steam, the only parts which actually come into continuous contact with superheated steam are the inlet valves on the high-pressure cylinder, for all other parts of the engine beyond this point, cylinder and piston, are at a mean temperature lower than the steam temperature entering, due to the fact that steam with even 100° superheat becomes saturated by the time the piston travels to the point of cutoff in the high-pressure cylinder. We found that our lubricating problems were, therefore, no more difficult with superheated steam, than with saturated steam.

We will now consider the comparisons of the performances of steam-turbine-driven centrifugal pumps, with and without the use of superheated steam. Our turbine-driven pumps are installed in the same station with the low-service compound pumping engines previously referred to. Two of these are of the single-stage centrifugal type, each of a nominal daily capacity of 35,000,000 gal They were installed in 1913 and have been in active service ever since. The test duties of these pumps at a head of 65 ft. was 100,000,000 ft.-lb. per 1,000 lb. of saturated steam A recent test run under the same pumping conditions, but with 124 degrees of superheat instead of saturated steam, showed a duty of 115,000,000 ft.-lb. per 1,000 lb. of steam, an increase in duty of 15 per cent. The physical condition of the pump may be said to have been the same during the two tests, for the reason that the unit had just been overhauled.

On the same turbine-driven centrifugal pump, comparative tests were made to determine the difference in duty, with the same superheat and vacuum, before and after the pump was overhauled, as just described. The duty before overhauling was 93,500,000 ft.-lb. per 1,0[illegible] lb. of steam and after overhauling was 106,000,0[illegible] showing a saving of 13.3 per cent, due entirely to ov[illegible] hauling.

It might be well to mention that the pumps at ou[illegible] low-service station are subject to abnormal wear du[illegible] to their pumping raw river water containing muc[illegible] sand in suspension.

Commercial Motor Car Production Shows Large Increase

Seven Eastern States Register 40 Per Cent of Estimated Vehicles in Use During 1920— 1½ to 3½-Ton Units Popular

APPROXIMATELY 370,000 commercial motor vehicles will be manufactured in the United States during 1920, exceeding the 1919 production by approximately 65,000, according to information recently acquired by the *Commercial Vehicle*. This figure also exceeds by approximately 20,000—save those vehicles operated by the War Department—the total number of commercial motor cars in operation in the United States during 1918.

While exact figures are not available on commercial motor vehicle production in the United States during the past few years, the *Commerce Vehicle* has made an estimate of this production as follows:

1910	9,500	1916	98,000
1914	15,000	1917	190,000
1912	25,000	1918	250,000
1913	28,000	1919	305,000
1914	35,000	1920	370,000
1915	74,000		

Eliminating trucks exported and those sold to and operated by the War Department from these production figures, the estimate is made that during 1918 there were in domestic use 351,000 commercial motor vehicles. During 1919 this number was increased to 480,000 and to an estimate of 674,300 during the current year.

Many states reported, on Jan. 1, 1920, enormous increases in registration of commercial motor vehicles over the preceding year. Not all the states register commercial cars independent of passenger cars, so that comparative registration figures between the years 1918 and 1919 are not available. However, the seven eastern states of Connecticut, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island, in registration figures reported as of Jan. 1, 1920, registered a total of 267,319 commercial motor vehicles or approximately 40 per cent of all trucks estimated as in use during this year. No doubt the registration figures are much higher this year as those seven states reported an average increase in commercial vehicle registration during 1919 of 35 per cent over 1918. Massachusetts reported the highest per cent increase—61 per cent—and New Jersey, the lowest—24 per cent.

While no figures are available on the classification of vehicles registered or produced according to capacity, Table I indicates the number of truck models announced by various manufacturers from 1913 to 1920, inclusive, and for all capacities from those under ½ ton to 7 tons and over, as well as tractors. The chart would at first indicate that manufacturers were running to the production of units ranging in capacity from 1½ to 3½ tons, but there may be other explanations than this in the fact that the number of models of 1½-ton trucks, for

TABLE I—NUMBER OF TRUCK MODELS OF VARYING CAPACITIES MANUFACTURED DURING YEARS LISTED

Capacity—Tons	1913	1914	1915	1916	1917	1918	1919	1920
Less than ¾	13	15	19	8	3	4	1	1
¾	19	28	31	28	19	13	14	6
1	47	48	44	40	23	26	18	12
1½	59	72	68	65	54	64	68	47
2	46	50	66	54	45	51	75	90
3	62	62	76	93	70	87	89	73
4	5	10	19	17	29	34	41	62
5	55	48	43	33	20	21	17	12
5½	14	14	28	38	48	64	62	67
6	19	17	15	14	12	11	11	10
5 and 5½	49	44	45	43	42	52	59	60
6 and 6½	9	16	18	14	9	10	8	6
7 and over	6	8	12	10	7	9	6	4
Tractors	0	0	0	12	8	16	18	9
Total	403	422	485	469	389	462	487	459

instance, has increased so rapidly within the past few years. Notwithstanding arguments to the contrary, it is apparent from the table that models within these capacity ranges, are popular with manufacturers. However, there is no decrease in the number of 5- and 5½-ton trucks manufactured, judging by the number of models reported by manufacturers, and it is a patent fact that highway engineers will have to take into fuller account such heavy units, the frequency of whose appearance on the public highways can only be determined by numerous traffic counts.

TABLE II—TRUCK WEIGHTS—CHASSIS AND BODY

Capacity	Chassis, Pounds	Body, Pounds	Total, Pounds
¾-ton	2,400	750	3,150
1-ton	3,000	900	3,900
1½-ton	3,500	1,050	4,550
2-ton	4,500	1,200	5,700
3-ton	6,000	1,500	7,500
5-ton	8,000	1,800	9,800
6-ton	8,700	1,900	10,600
7-ton	9,400	2,000	11,400

There are other considerations with which the highway engineer is interested besides the increase in truck production. Among these are truck weights, both chassis and body, a compilation of which is made in Table II above.

Highway Construction in Canada

The Canadian Minister for Railways has approved plans submitted by the Manitoba government for extensive highway construction under terms of the Dominion Highways Act. The expenditure contemplated will amount to about $3,500,000, and about 4,000 mi. of roadway will be improved. The highways approved are those from Winnipeg to Lake Winnipeg; Winnipeg to Rainy River; Winnipeg to Emerson, at the United States boundary; Winnipeg to Reston, connecting with western roads there; Winnipeg to Portage la Prairie and Brandon to Elkhorn, and connecting with the Saskatchewan system at Russell. There is also a system starting at the United States boundary and extending through the Province of Manitoba. Plans have also been approved for the expenditure of about $40,000,000 improving the highways of Ontario and Quebec. The outlay contemplated in Ontario is $22,000,000, of which the Dominion Government will contribute $6,800,000 and the Province $12,000,000 and the municipalities $4,400,000. Quebec's projected outlay is $17,390,000, of which the Dominion will pay $5,000,000 and the Province and municipalities the balance. An additional roadway will be built through the central part of the Province of Manitoba, extending north and south, with a series of intermediate trunk and market roads. All of the provinces are participating in the Federal scheme of highway improvement, which is calculated to revolutionize public highway transportation in Canada.—*Commerce Reports.*

Railway Water Supply at Atkins, Iowa

Electric Pumps at River Supply 300,000 Gal. Daily by 5-Mile Main to Terminal—Test of Surge in Long Pipe Line

By Fred D. Yeaton
Assistant Engineer, Chicago

WATER supply of good quality and ample quantity was an important factor in the selection of Atkins, Iowa, as the location for a new engine terminal on the Chicago, Milwaukee & St. Paul Ry. This railway water supply system has the unusual features of a 5.3-mile force main and duplicate pumping units. Atkins is on the main line between Chicago and Omaha, being 104 and 119 miles, respectively, from the adjacent division points of Savanna, Ill., and Perry, Iowa. Water is obtained from the Cedar River, at a distance of five miles, as the terminal could not be located closer to the river on account of the topography and the alignment and grade of the railroad.

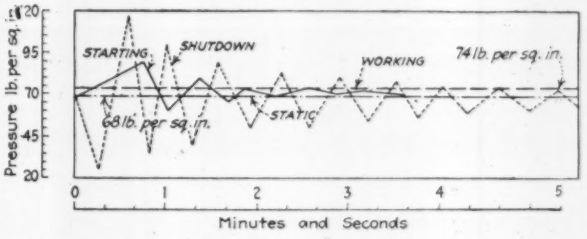


FIG. 1. PROFILE AND LOCATION OF VALVES ON LONG FORCE MAIN TO ENGINE TERMINAL

Shallow well water at Atkins is scarce and the deep well water contains 45 grains of incrusting solids per gallon, 40 grains being calcium sulphate and magnesium sulphate which form a hard scale. The river water contains less than ten grains of incrusting solids per gallon, eight grains of which are calcium and magnesium carbonates that form a soft scale and two grains are non-incrusting solids. The maximum rise and fall of the river is 15.2 ft. As the water is somewhat muddy during high stages, land for settling basins was obtained, but so far it has not been necessary to build these basins. The maximum demand has been 350,000 gal. per day, but the average is 300,000 gal., divided approximately as follows: Filling locomotive tenders, 150,000 gal.; washing out and filling locomotive and stationary boilers, 120,000; cinder pit, 15,000; hotel, toilets and wash bowls, 12,000; coaling station, 3,000 gal. To provide for future requirements the plant is designed to handle 750,000 gal. per 24 hours.

From the river, the water flows 824 ft. through an 18-in. pipe to the pumphouse. For cleaning this pipe there is a manhole 140 ft. from the river, and a 12-in. branch from the manhole to a small creek provides an emergency supply if the main intake should become clogged during high water.

As duplicate pumping units are advisable for locomotive terminals where a continuous supply of water is essential, two triplex pumps are installed, each having a rated capacity of 622 gal. per min. at 42 r.p.m. and a maximum safe working pressure of 160 lb. They are operated at about 30 per cent less than the rated speed, because our experience is that in this way more reliable

service is obtained. One pump has a 25-hp. and the other a 30-hp. motor, current being supplied from the terminal. Each 10-in. suction pipe has a foot valve, and on the discharge pipe are air chambers and a 4-in. relief valve set to release at 125 lb. A telephone line enables the pumper to keep in touch with the water requirements and to call for assistance in case of breakdown. Revolution counters keep a record of the pumpage.

The 12-in. cast-iron delivery main has hub-and-spigot joints calked with jute and lead. The maximum theoretical lift is 180.1 ft., the equivalent pressure being 78.3 lb. Previous to backfilling the pipe line was tested in 100-ft. lengths by compressed air at 100 lb., leakage being detected by brushing the joints with a soap solution. After recalking the joints in one section the pressure was raised to 109 lb. and left on for 24 hours with a loss of only 4 lb. Air was used because it was impossible to obtain water for the purpose. A test after completion indicated that the leakage was less than 175 gal. per mile of pipe line per 24 hours.

Blow-off branches with 4-in. hose connections and gate valves are placed in the sags, and air relief valves at the summits, as shown in Fig. 1. The valves are in frost-proof manholes, marked by signs on cedar posts 4 ft. high. A 150,000-gal. steel tank is located near the roundhouse. Three water columns supply the locomotives. Fire hydrants and gate valves are located at convenient points, the valves controlling the fire main being marked by tall posts. Charts showing the locations of the pipe lines, valves, blow-off branches, hydrants and water columns, together with instructions for operating the water-supply system, have been framed and posted at the pumphouse and in the foreman's office. The instructions read as follows:

> Both pumping units must be maintained in first-class working order and generally operated alternately. The pumper must notify the roundhouse foreman immediately in case of trouble and call on him for assistance. Air valves have been placed at summits and blow-off and gate valves in the sags of the pipe line. Air valves must be carefully inspected by the pumper every week. All valves must be opened and shut slowly. All gate valves must normally be left open when pumps are in operation. Mud must not be allowed to accumulate in pipe line. Blow-off valves must be opened at intervals to determine whether mud has accumulated. In blowing off, start at blow-off No. 1. Blow off if possible when storage tank is full.

One pumper is employed. When it is necessary to operate at night, he can start a pump and depend on the night foreman at the terminal to cut off the current when the tank is filled, the pressure gage indicating the height of water in the tank. If the pumper fails to stop the pump when the tank is full, an automatic alarm at the terminal warns the foreman to cut off the current. Glass water gages show the pumper the amount of air or water in the air chambers; pet cocks on the suction pipes can be opened and air pumped into the chambers.

A test to determine the pressure in the 12-in. pipe line due to surge is shown in Fig. 2, in the form of time-pressure curves for the 25-hp. pump. The static pressure with the storage tank full is 68 lb. and the working pressure is 74 lb. Maximum and minimum pressures of 120 and 125 lb. occurred in starting and stopping the pump, but by stopping suddenly and then starting before the surge had died down the pressure reached 135 lb. By starting and stopping the pump slowly the pressure could be controlled and held within the limits of 60 and 80 lb. When the valve at a wa[illegible] column near the terminal was closed suddenly a sur[illegible] of 120 lb. pressure occurred at the pumphouse. The[illegible] results show that a margin of safety should be allow[illegible] for excess pressures in pipe lines and at pumps.

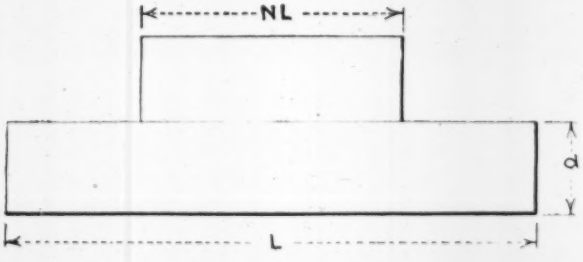
This water-supply system was built during 1919 at [illegible] cost of about $130,000: Pipe line from pumphouse [illegible] tank, $95,000; distribution pipe, water columns and storage tank, $12,000; pumphouse, pumps, machinery and connections, $16,000; pumper's dwelling, $1,000; intake, $6,000. Material for the pipe line was furnished by the railway company and placed by a contractor. The intake pipe, water columns and pumping machinery were placed by the company's forces, E. L. Sinclair being the engineer in charge. The design and construction of the plant were under the direction of C. F. Loweth, chief engineer, Chicago, Milwaukee & St. Paul Ry.

Practical Design of Concrete Cap Footings

By H. H. Frenzel

Corrugated Bar Co., Inc., Chicago, Ill.

TWO types of concrete footings are commonly used; the plain slab footing in which the column rests directly upon the slab, and the footing in which the column rests upon a cap which in turn rests upon the footing slab. Specifications generally read that cap and footing slab be poured monolithically. The use of the first type is generally restricted to small footings; the latter is used on the larger and more important footings. A variation from these two types is used sometimes in which the footing slab is sloped from the column or cap to the outer edge of the footing, but while this type is economical with respect to materials it is



Soil Value Lb. per Sq. Ft	N	$F = \frac{d}{L}$
2,000	0.4	0.094
3,000	0.4	0.121
4,000	0.4	0.141
5,000	0.4	0.156
6,000	0.4	0.169
8,000	0.5	0.162
10,000	0.5	0.206

Punching shear = 120 lb. per sq.in.
Diagonal tension = 40 lb. per sq.in.

open to objection on account of the added forming necessary for the slab.

Nothing can be added on the design of plain slab footings; the following deals entirely with the cap footing. There seems to be no general method of proportioning cap footings in use. The total depth is generally determined by the punching shear at the edge of the column, but the size of the cap and the relative depths

of the caps and the footing slab varies with the ideas of different designers.

The concrete in the footings is the major part of the cost, the cost of the steel being small in comparison. The footing designed to meet the requirements of diagonal tension and shear which contains the smallest amount of concrete will, almost without exception, be the most economical. It was found from the design of a large number of footings that for soil bearing values of 2,000, 4,000 and 6,000 lb. per square foot the most economical size of cap was about 0.4 of the size of the footing slab; for soil bearing values of 8,000 and 10,000 lb. per square foot the caps should be about 0.5 of the footing slab.

The depth of the footing slab should be proportioned for either diagonal tension requireemnts, or for punching shear at the edge of the cap, depending upon which gives the larger value, the diagonal tension being taken at a distance from the edge of the cap equal to the effective depth of footing slab.

In the design of a footing the required total depth is generally determined by the punching shear at the edge of the column, the size of the footing slab is determined by the soil bearing value. In the accompanying table are given the proportions which with few exceptions will give the most economical footing.

Borrow Pit for Levee Forms Drainage Canal

Combined Protection System for Palo Verde Valley Will Lower Ground Water Level and Minimize Levee Saturation

A LEVEE to protect 100,000 acres of low land in the Palo Verde Valley, California, from submergence by the summer flood water of the Colorado River is being constructed from material taken from a continuous borrow pit on the land side. The function of the resulting drain is to carry away possible seepage through or under the levee during flood periods as well as to lower the general ground water level of the valley throughout the year. The river has a meander length of 45 miles along the western side of the valley which it has blanketed with rich alluvial silt deposits from recurring flood waters.

The complete levee system consists of 34 miles of earth levee, all of a standard section of 12 ft. top width, 3 to 1 slopes on the river side and 2 to 1 slopes on the land side. The levee is located at least a quarter of a mile from the channel of the river and from this minimum up to whatever was required to secure a satisfactory alignment from the intake of the irrigation system, at the extreme north end of the valley, to the extreme south end where the river turns to the west to meet the mesa. A standard-gage railroad track will be laid on top of the levee for its full length providing means for revetting with rock any portion of the levee that may be endangered by flood waters. This rock protection is to be given, however, only to those sections which may be threatened with scour during high water.

In deciding upon the design of the levee it was concluded to construct the borrow pit so that it would constitute a continuous drain canal paralleling the levee on the land side. The canal will furnish a means for carrying off the ground water, the table of which is high along the line of the levee, thus helping to lower the entire ground water level of the valley; and it will carry off the water which would tend to accumulate near the levee when flood waters stand against its river side. The levee was considered as a temporary earth dam which would not withstand high heads of water for any length of time but which would be fairly safe for floods which continue for more than two months. Records in the district show that when flood waters stand against a levee for more than two months the water content becomes so high that the levee is in great danger of a breach. The drain canal constructed along the Palo Verde levee is expected to prevent saturation to a certain extent since the water table at the levee can at no time be higher than the level of the water in the drain canal.

Construction and Costs

As water was encountered in all test pits within 5 ft. of the surface, the specifications for the construction of the levee require that its outer portions be built first, filling in the core with the wet material excavated under water in the borrow pit. This is to provide a tight levee with a core more compact than could ordinarily be built with teams and Fresno scrapers. The specifications also require that a berm 50 ft. wide be left between the edge of the borrow pit and the inside toe of the levee slope.

It was found that levee construction of this sort would have an almost prohibitive cost of 45 to 50c. per cubic yard at the present price of teams and labor in the valley. Records of the district show that the work as constructed by drag-line excavator, which was the method decided upon, has averaged 20c. per cubic yard.

The work is being done with four drag-line excavating machines with steel booms varying from 55 to 75 ft. in length, and buckets of 1½ to 3-cu.yd. capacity. These machines operate on the berm and by means of the long boom the material is excavated from the canal and put in final position in the levee with one handling. They are operated by gas engines burning distillate and carry a crew of four, consisting of operator, engineer, roustabout and a man on the levee to direct the placing of material. The 3-cu.yd. machines average (including breakdowns and stop for repairs) 1,100 cu.yd. per shift of nine hours. A length of 27 miles will be completed this season

The work is being done for the Palo Verde Joint Levee District of which J. C. Allison is chief engineer and general manager. The foregoing information was supplied by Paul N. Entemann, Mr. Allison's associate.

Housing Progress in England

Plans for 242,549 houses had been submitted by various local authorities to the British Ministry of Health up to July 31, and of these 228,422 had been approved. Bids had been received for building 153,282 houses, of which 135,358 had been approved, while contracts for 81,015 houses had been signed and about 5,800 of the houses contracted for were under construction or completed. The total number of housing projects (as contrasted with separate houses) submitted to the Ministry of Health up to July 31 was 10,842, comprising about 72,500 acres of land. The schemes approved totalled 7,434 and involved 52,000 acres.

Approach Spans Compared with High Bridge Abutments

Reduction of Scour and Elimination of Retaining Walls Favors Approach Spans—Costs in a Wisconsin Case

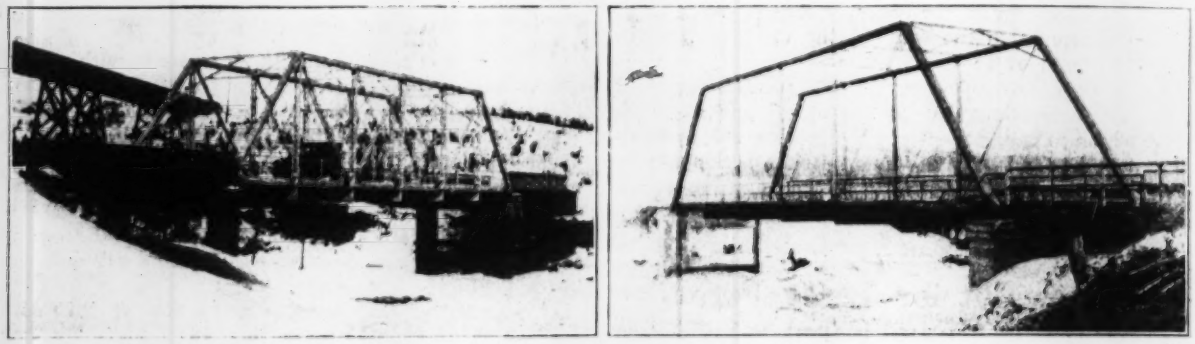
By M. F. Torkelson
Bridge Engineer, Wisconsin Highway Commission, Madison

ONE of the most common mistakes in the design of highway bridges is the tendency to use excessively high abutments. This mistake, in the writer's opinion, usually comes about through a desire on the part of an inexperienced designer to cut the waterway down to a minimum, believing that by so doing the expense of construction will be reduced proportionately. In numerous instances of this kind short-span bridges on excessively high abutments have come to grief through one or both of two causes: failure of the abutments due to their inability to resist earth pressure, and scouring out of foundations due to restricted waterway.

High retaining walls are practically always objectionable, and where possible should be avoided. It can never be possible to design rationally to resist earth pressure because it is practically impossible to foresee just what is going to be placed against the wall. The pressure exerted by the same material placed under different conditions may vary between wide limits, and when provision is made to resist the most severe conditions (as is the only safe plan) the expense is very great, becoming practically prohibitive when walls are high.

The Wisconsin Highway Commission's practice in cases where excessively high abutments would be required, if the minimum-length span were to be built, is to provide approach spans set on concrete columns. The earth embankment is allowed to take its natural slope and protected against washing by heavy riprap. In cases where the current of the stream is strong, the approaches are made of sufficient length to keep the fresh fill well out of the main current and especial precautions in the way of protection are taken. In cases where there is little or no current there is no hesitation about allowing the embankment to take its natural slope in the water and protecting the exposed portions of the embankment against such current and wave action as may exist. In this way large economies have been effected in a number of designs, which also have the advantage of considerable additional waterway, which is of assistance in cases of extreme floods.

The principles stated are well illustrated in a case of highway bridge construction in Douglas County, Wis., about ten miles from Superior. Where Pattison Avenue, the main road south from the city, which has since become a state trunk highway and which leads to the falls of the Black River, a scenic spot of unusual interest, crosses the Nemadji River, there was a light steel span of 102 ft. length, 16 ft. roadway, on a substructure consisting of steel tubes with steel backing and steel wings, the wings and backing being supported by means of 12-in. I-beams driven into the ground as piles. This span has just been replaced by a new and stronger bridge (shown at the left in the illustration herewith), and the old span has been re-erected at a site one mile up the river, replacing an old wooden structure known as the Drinkwine bridge. In both cases, pier and approach span construction was applied at large saving of cost.



PIER AND APPROACH-SPAN CONSTRUCTION APPLIED TO TWO BRIDGES OVER NEMADJI RIVER
Large savings over abutment construction were realized in both cases. The Pattison Ave. bridge, at the left, would have cost $7,000 more if the approach spans had been replaced by retained fill.

At Pattison Avenue the Nemadji River flows in a deep ravine and carries a large amount of drift. This made it necessary to construct a bridge much higher above the stream bed than ordinarily would be required, with the result that abutments, whether of gravity or of cantilever type, would have been exceedingly expensive. The design finally adopted consists of a central span of 100-ft. length, 20-ft. roadway, with reinforced-concrete approach spans of 30-ft. length. The central span and the stream ends of the approaches are supported by concrete columns 4 ft. square, set diagonally. These columns are carried well below stream bed and set on timber piles. The shore ends of the approaches are set on much smaller concrete columns which are carried down to a depth believed sufficient to insure them against ever being washed out and, likewise, set on wooden piling.

The quantities in the approaches as designed, and the quantities that would have been required for cantilever abutments of reinforced concrete, are as follows:

Approaches As Designed		Reinforced-Concrete Abutments
Concrete	205.5 cu.yd.	644 cu.yd.
Steel	21,980 lb.	8,500 lb.
Wooden piles (24 ft.)	52	about 100
Riprap	220 cu.yd.	75 cu.yd.

The net saving in this particular case amounted to about $7,000, or 64 per cent of the total cost of the finished bridge. An additional advantage of the design adopted is the increased waterway of about 60 ft.

The same general type of substructure was also used at the Drinkwine site for the old Pattison Avenue span.

but the work was cheapened by pulling the 12-in. I-beams used in the original Pattison Avenue substructure and using them as stringers in the approach spans. The quantities of new material in this substructure are only 110 cu.yd. of concrete, 5,930 lb. steel reinforcement, 52 piles and 43 cu.yd. riprap.

The work was done in 1919 by contract. The cost of the Pattison Avenue bridge to the county was $10,998, and the cost of the Drinkwine bridge $5,500. Both structures are giving excellent satisfaction.

Cloudburst in Toledo Floats Pavement Away

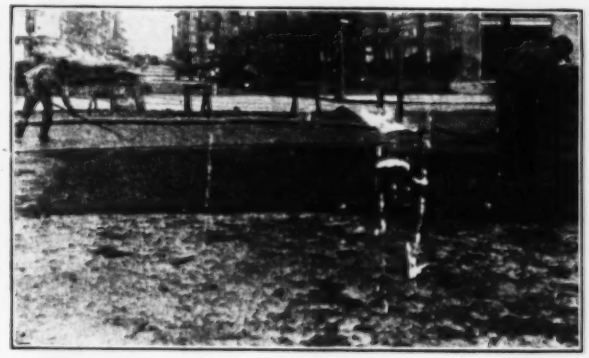
Greatest Intensity Recorded Since Weather Bureau Established—Wood Blocks Replaced on Asphalt Binder as Cushion

AN UNPRECEDENTED downpour in Toledo Aug. 16 damaged a section of wood block paving six blocks long on Jefferson St., 1,200 ft. on Monroe St., a like amount on Bancroft St. and on ten other isolated spots. Blocks were found floated as far away as six squares and two solid squares of Jefferson St. floated to Madison St., one block south, where many were found undamaged in cellars. It is estimated that thirty cellar walls under small frame houses located in depressions caved in.

SAND-CEMENT CUSHION CAME AWAY IN SMALL SLABS

Damage to private property was greatest in the downtown district and was confined mostly to wetting goods stored in cellars. The *Toledo Blade* lost $10,000 worth of paper. The Broadway water pumping station ran for four hours with the pumps submerged. Other utility stations and private power plants had similar difficulties of short duration. No lives were lost.

While many of the older sewers in the downtown districts are admittedly underdesigned to care for extraordinary rains, sewers built under present assumptions of design, viz., a 1-in. per hour rainfall with a 50 per cent runoff factor, would be decidedly inadequate. However D. H. Goodwillie, director of public service, states that much less water would have run down the streets had it been able to pass the clogged inlets.



ASPHALT BINDER COURSE READY FOR ROLLING TO RECEIVE WOOD BLOCK SURFACE

From the Toledo Weather Bureau the following records have been obtained as to the intensities which have not been exceeded since the bureau was established in 1871:

TABLE I. GREATEST INTENSITY IN GIVEN PERIOD

Time	Aug. 16	Highest Record Since 1903	
5 min.	0.65 in.	0.54 in.	July 13, 1909
10 min.	1.25 in.	0.91 in.	July 13, 1909
15 min.	1.78 in.	1.08 in.	July 13, 1909
30 min.	2.87 in.	1.89 in.	June 24, 1911
1 hour	3.58 in.	2.14 in.	June 24, 1911
2 hours	3.65 in.	2.24 in.	June 24, 1911

The rain started at 7:06 a.m. and ended at 8:35 a.m. In the 24-hour period 4.55 in. fell, rain actually falling for five hours and 24 minutes. It continued in excess of 1 in. per hour for 46 minutes, when 3.40 in. fell, being therefore many times the rate for which the sewers were designed.

For eight minutes after the rain started the Weather Bureau reports 0.01 in. fell and the rate then became "excessive." The five-minute accumulation record thereafter for an hour is as follows:

Minutes	Accumulation	Minutes	Accumulation
5	0.09 in.	35	2.34 in.
10	0.12	40	2.93
15	0.32	45	3.20
20	0.75	50	3.38
25	1.17	55	3.49
30	1.74	60	3.58

Repairs to pavements were started immediately by the city, the wood blocks being hauled back to the various streets and piled on the sidewalks and parkways. All of the wood blocks for six blocks on Jefferson St. were removed, since that part of the pavement which had not been floated was badly disturbed and was loose previous to the flood.

Jefferson St. paving had been down six years. It was laid with 3½ in. lug blocks preserved with 16 lb. creosote on a sand-cement cushion and the joints filled with sand. The blocks are in good condition and Mr. Goodwillie estimates 75 per cent of them will be salvaged.

A new method of laying is being used partly because of the difficulty of obtaining cement for the standard sand-cement cushion. After removal of the sand-cement cushion, which came away in pieces of from 6 to 12 in. across, the irregularities in the concrete base are being filled and a smooth grade being made by a ¾- to 1-in. layer of asphalt binder. It is being placed and rolled exactly as for a wearing surface of asphalt. The blocks are then placed after cleaning and a squeegee coat of mastic of sand and tar pitch brushed into the joints.

POURING HOT TAR MASTIC OVER RELAID WOOD BLOCKS

The engineers are of the opinion this filler will adhere much more closely to the asphalt binder and form a better bottom seal against water than if placed on a sand-cement cushion.

Monroe St. paving is 16 years old. It was laid on a poorly finished rough concrete base which shows distinct wear under the wheel tracks. Within two years it will have to be repaved anyway, so the three places aggregating 1,200 ft. will be replaced with a sand-cement cushion, utilizing the recovered 4-in. blocks.

On Bancroft St. three intersections are gone. The paving is eight years old and the blocks were laid on an old concrete foundation which had been patched in many places. In consequence the sand-cement cushion had cracked badly and had given much trouble, mostly due, according to Mr. Goodwillie, to the patched foundation. It will be repaired with an asphalt binder cushion in the same manner as Jefferson St.

As to the flotation propensities Mr. Goodwillie says there seemed to be no consistent reasons assignable. The lowest spot in Robinwood Ave., under 2 ft. of water and laid on a plain sand cushion never moved, while two blocks away on the same street under similar conditions of paving a large area was floated out of place.

The city let contracts for the Jefferson St. job at $35,000, Monroe St. at $18,000, and Bancroft St. at $12,000. A total of $105,000 is estimated to complete all of the daamged pavements.

Peru Passes New Road Law

The Peruvian Congress recently passed a law making it compulsory for all males from 18 to 60 years of age to work on the public highways for a certain number of days per year. However, examptions may be secured on condition that payment be made to the Government of a certain sum of money, which sum shall be fixed for each district. At the present time there are but 1,040 mi. of road in the Republic of Peru, while 391 mi. additional are projected. Trade Commissioner Jackson expresses the opinion that practically all the laborers in Peru at the present time have enough money to pay cash instead of doing the work on the roads; therefore it is expected that the bulk of the returns from this act will be in money rather than in labor. The estimate of returns was set at $2,500,000 per year, and the Minister of Hacienda states that already the collections are running above that rate.—*Commerce Reports.*

Bridge Floor With Steel Ties Bedded in Concrete

Shallow Solid Floor Design on Track Elevation—Girders Have Concrete Casing—Rail Bolts Are Clear of Ties

A REINFORCED concrete slab encasing and supported by transverse floor beams and having steel ties embedded in it is the novel floor construction adopted by the Cleveland, Cincinnati, Chicago, & St. Louis Ry. for some of its track elevation bridges at Indianapolis, Ind. These are double-track triple girder through bridges built in 1919 at the east side of the city, on the Chicago-Cincinnati division (see *Engineering News-Record*, Aug. 7, 1919, p. 265). The object of ths design is to obtain a solid waterproof floor of minimum depth.

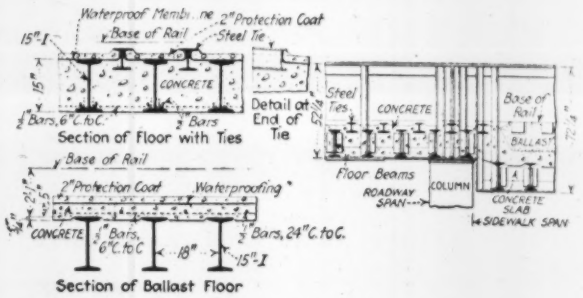


FIG. 1. BRIDGE FLOOR HAS STEEL TIES EMBEDDED IN CONCRETE

Framed between the girders are 15-in. I-beams spaced about 18 in. c. to c. Transverse bars having their ends bent up vertically are laid on the bottom flanges of the I-beams, and in the corners of the bent bars are laid longitudinal bars. Concrete is filled between the beams, flush with the top and bottom flanges, and in this concrete the 6-in. steel ties of H section are embedded to about half their depth. One of the bridges is on a curve and the ties are inclined in the concrete to give the required superelevation. The concrete is a 1:2:4 mix, with 20 lb. of hydrated lime per barrel of cement.

After the concrete had set it was covered with a waterproofing membrane, this being carried under the top flanges of the steel ties and flashed. Upon this

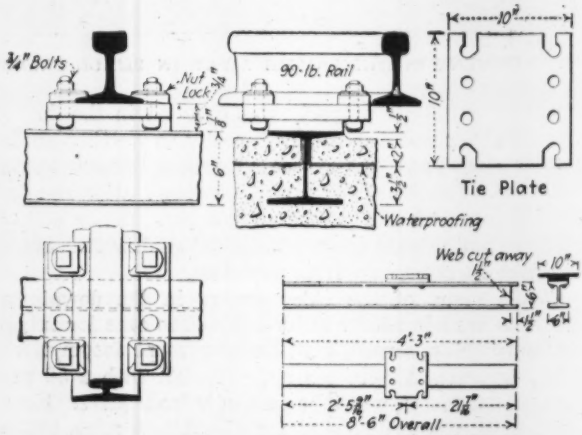


FIG. 2. RAIL FASTENINGS ON BRIDGE FLOOR

membrane is laid a 2-in. protective course of 1:2 cement grout, which is given a smooth sidewalk finish. The tops of the ties are ½ in. above this finished surface, but the grout is filled in under their flanges, as shown.

Bolted clip fastenings of unusual arrangement secure the rails, which are of the 90-lb. A. S. C. E. section. The 6-in. steel ties are 8½ ft. long and have at each rail seat two plates secured by rivets which are countersunk in the top plate. The lower plate is a ¾-in. filler, 6 x 10 in., and the upper plate is 10 x 10 in., ¾-in. thick, with slotted holes for the track bolts. The slots are so arranged as to give lateral support to the bolts and

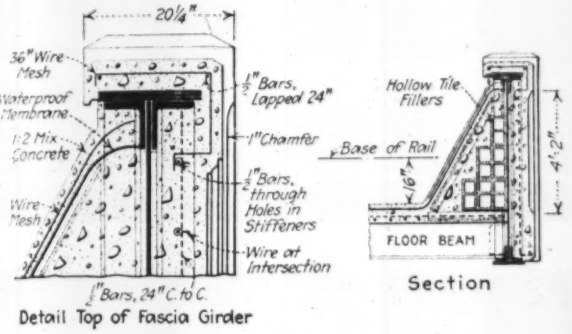


FIG. 3. CONCRETE CASING OF GIRDERS

to permit of their renewal without disturbing the concrete.

This floor construction is used only on the roadway spans, a ballasted floor being used for the sidewalk spans and for the triangular portions between the girders and abutments of skew bridges. For these parts of the floor a waterproofed 7-in. reinforced-concrete slab is laid upon the I-beams, having its top 18 in. below the base of the rail.

Concrete casing is used on the columns and girders of these bridges, for protection of the steel and to give an architectural finish to the structure, as required by the city. The columns as concreted are of octagonal section, with vertical bars at the corners and hoops spaced 12 in. apart. On the inside of each girder the concrete is filled to the clearance line, hollow tile backing being placed in the concrete to reduce the weight. This filling is packed under flashing angles on the top flange of the girder, and the middle girder has the top surface of its flange uncovered. For the exposed side of each outside girder the concrete is shaped to form a paneled fascia girder and is carried over the top flange.

The type of floor construction described above weighs about 2,100 lb. per sq.yd. (for I-beams, ties, rods and concrete). Its details are calculated for Cooper's E-60 engine loading. It was designed under the direction of C. A. Paquette, chief engineer, and J. B. Hunley, engineer of bridges, of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Further Delay to Channel Tunnel Project

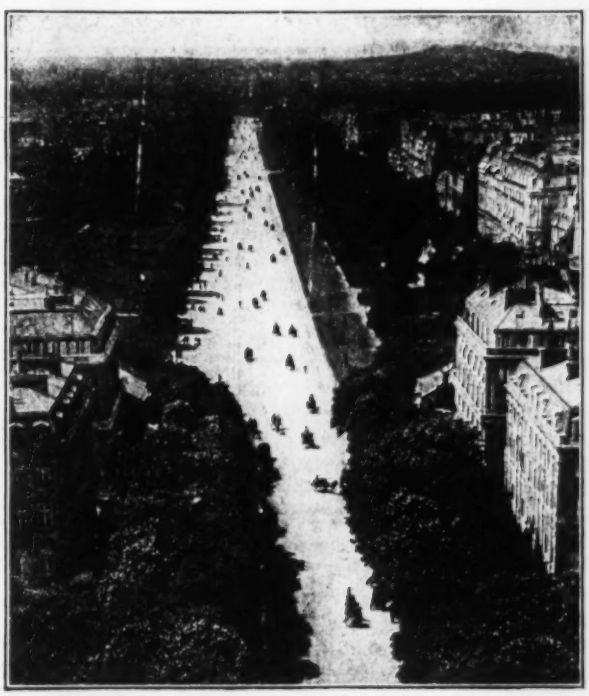
A recent statement of the British government to Parliament indicates that no favorable decision on the Channel tunnel project has been reached as yet. A recent re-examination of the proposed tunnel enterprise by military and naval authorities appears to have led to conflicting opinions, and considerable further delay in the decision on the project is therefore expected.

Notes from Foreign Fields

FROM LONDON TO GLASGOW

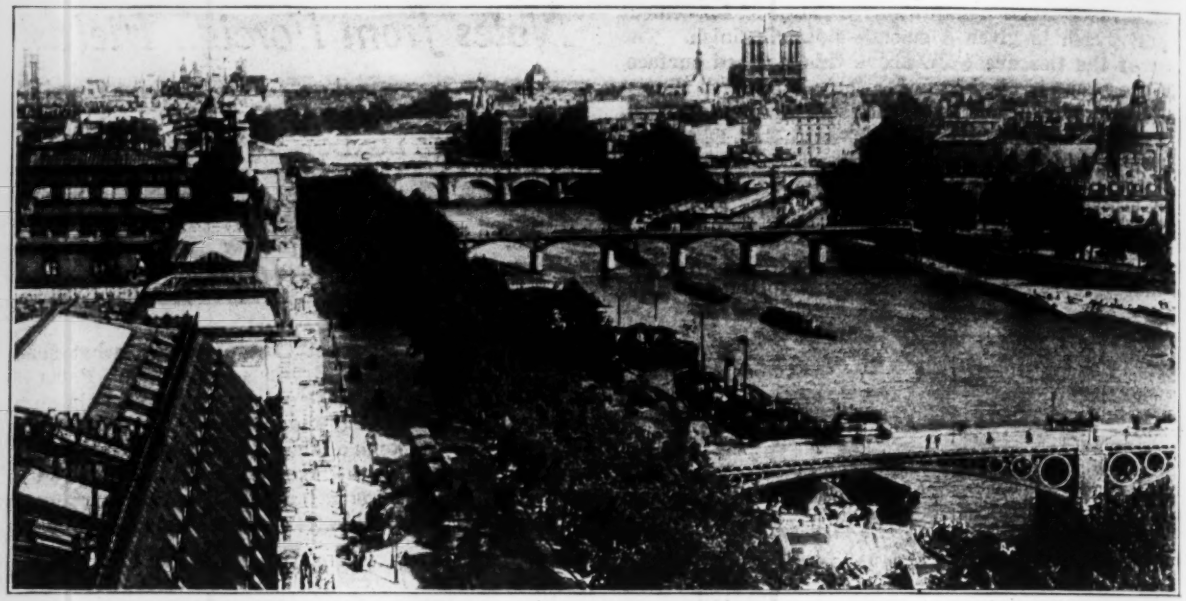
BY E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

IF ONE grows enthusiastic over Brussels, what shall one say of Paris? If Brussels is beautiful, Paris is magnificent. In a day or so one makes the acquaintance of the business district and of that much-frequented section lying just north of the Louvre and the Tuilleries. Judging by other cities this section should be the sum total of the city's fine neighborhood—with possibly a fashionable residential section and few small parks elsewhere. Not so with Paris. The broad avenues, the tree-lined boulevards, the high-class well-kept buildings, the good pavements, the squares, the monuments, the clean streets are everywhere. Paris is the only homogeneous large city, structurally speaking, I have ever seen. As an American remarked one night as we watched the moonlit city from the Concorde Bridge, "Isn't it satisfying to see a city that is completed?"



AVENUE BOIS BOLOGNE—LOOKING WEST

Undoubtedly the vistas in Paris are not surpassed anywhere. To stand in the main avenue of the Garden of the Tuilleries as the sun is setting, to look eastward, where the view is closed by the Arc de Carousel and the Louvre, then westward past leaping fountains, through the Place de la Concorde to the Arc de Triomphe, through which at that hour the sun casts its golden rays, is to see the highest art of the city planner.



THE OLD CITY ISLAND AND THE SEINE, S. E. FROM THE LOUVRE, PARIS

To stand again in the Place de la Concorde, that greatest of public squares, to drink in its magnificent extent, to range with the eye from the Grecian portico of the Chamber of Deputies on the south to that wonder of classical architecture, the Church of the Madeleine, on the north, is to have gained a standard by which all planning of squares is to be judged.

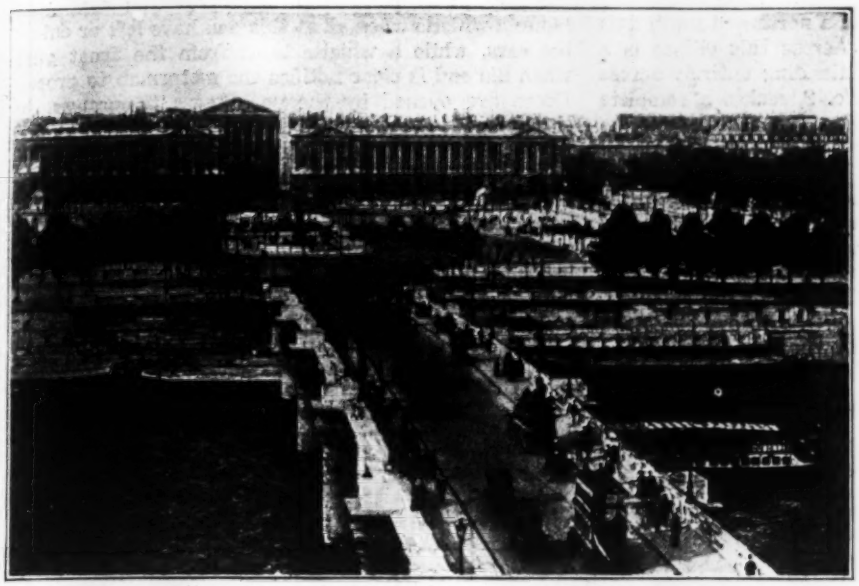
One could go on and describe the whorl of boulevards starting from the Arc de Triomphe in the Place de L'Etoile, the sloping gardens from the Trocadero to the Eiffel Tower, the plan of the boulevards, a dozen other magnificently planned features, but the resulting impression on the reader would be merely to accentuate what is comprehended in the phrase, the city magnificent.

One is tempted to ask when we shall do our city planning as well. The answer, of course, is that we shall never do it so well. The genius of a race is here expressed in its capital city, and that genius is artistic. We need not belittle our efforts. Our genius lies along different lines. We shall continue to build great cities —great in population, in commercial activity—but we shall not make them uniformly beautiful. We shall make them sanitary, we shall care well for the traffic, we shall have here and there beauty spots, but we shall not have cities that bear the artistic touch of Paris.

But if we cannot expect our average alderman, who is, after all, an expression of the average citizen, to think in terms of Parisian planning, we can, at least, demand that those responsible for the planning of the city of Washington show a great deal of liberality in the beautifying of the capital. We have a good foundation, but it is a foundation merely. We need, for example, half a dozen new great buildings for the departments. We should have them in fine settings, not fronting on narrow, built-up streets, as does the Interior Building. Should not a first requisite for service on the congressional committees in charge of District matters be a trip to Paris? That sounds like an extravagant suggestion, and it might be for two-year members of the House, but it would probably pay with six-year senators.

The Seine.—To an engineer the Seine affords an interesting study. The bridges are of great variety, while the quays are a constant surprise because of their cleanliness and their failure to detract from the land-

BASTILE MONUMENT



THE PONT AND PLACE DE LA CONCORDE FROM THE CHAMBER OF DEPUTIES

scape. A stream through any of our cities serves one chief purpose, besides that of carrying ships: its banks are ideal for warehouses, factories and railroad tracks. They are the last place one would look for beauty, while our bridges too often are useful only, not ornamental as well.

At Paris, the Seine is tree-planted for its full length and streets run along both banks. The quays are stone paved, sloping upward from the water's edge to stone retaining walls which support the parkways and streets. It is a place to loiter and to catch vistas made by the winding stream.

The bridges are designed to fit into the picture. As bridging problems they are simple. The stream is shallow and not swift. Between banks the width is 500 ft. more or less, while the elevation of the paralleling streets is such that there is ample clearance for the shipping (barges and tugs) without approach ramps. With such a location and with appearance a factor the arch is the natural, and actual, solution. Most of them are of stone. Some are dependent solely on their proportions for effectiveness; others are highly ornamented. There are quite a number of decked steel-arch structures, and at a point near the west end of the city, where ground conditions favor a different type, there are two through steel-arch bridges.

Pavements

At the present time the pavements in Paris, due to enforced neglect during the war, are in bad condition. Repairs are in progress, but it will take a long time to get back to pre-war standards.

Traffic is dense, greater than that of London, I should say, and comparable to that of our American cities, but the average weight of vehicles is not as great as that of London or of American cities. Compared with our traffic or London's there are very few motor trucks, but taxicabs are more numerous than the proverbial bees around the honey jar. In the heavy vehicle class are the omnibuses. Traffic figures would be very interesting, but here, as in London, there are no recent traffic counts.

Wood block has become the favorite pavement in recent years, the area so paved having increased from 428,000 sq.m. in 1887 to 2,473,000 sq.m. today. In the same period the area in asphalt (rock asphalt) has increased from 302,000 sq.m. to 754,000 sq.m., while the area in stone block has decreased from 6,286,000 to 5,347,000, and that in macadam from 1,563,000 to 840,000. Waterbound macadam is considered entirely unsuited for Parisian conditions and is being replaced as rapidly as possible.

Despite the increase in the use of wood block and the decrease of stone, the latter is considered the normal type of pavement because of its lower cost, life and maintenance expenses being considered, the life averaging 22 years. Wood block and asphalt are used where noise is objectionable—wood block in the business center and in the de luxe residential sections, asphalt on narrow streets, with poor air circulation, where the superior resistance (compared with wood) to moisture and atmospheric changes are believed to recommend it. Asphalt is not used on grades of more than 2 per cent, wood block not on grades over 4 per cent. On steeper grades stone block is laid. The life of wood block has been 10 years, of asphalt 15 years.

Six-inch concrete foundations are used for wood-block and asphalt pavements, and for stone block where there are tramways, where the traffic is very heavy or where the subsoil is bad. Normally, though, stone-block are laid on sand on a rolled subgrade or on reshaped old macadam.

The street cleaning work I had not time to inquire about, but one feature was much in evidence—the flushing of the gutters. Water connections are provided at intervals along the curbs, and in the early morning hours, particularly, goodly flows of water are allowed to run down the gutters, the sweeping of the night before being carried by the stream, aided by long brooms, often manipulated by women.

THE PARIS SUBWAYS

THE average American's conception of a subway system is probably based on that of New York. To him a "subway" is a long high-speed underground railway, with express as well as local service. Philadelphians and Bostonians have somewhat different conceptions, based on the congested-area subway plan in those cities. The Paris system is quite different from both of these types—which is only another way of saying that conditions here are different than they are in New York or Boston.

Paris, unlike other Old-World cities, has not grown beyond its walls. Elsewhere in Europe the old limits have long since been overstepped and the suburbs have been absorbed by the expanding municipalities. Paris is,

roughly, elliptical, with a major axis (east and west) of about 11 km. (6.6 miles) and a north and-south axis of about 9 km. (5.4 miles). Across this ellipse is a network of subway lines, six extending entirely across the city, while one of them, No. 2, makes a complete circuit, at a distance of about 2 km. (1.2 miles) from the city wall. In addition there is a short connecting subway, and several of the lines have branches at their outer ends, the Nord-Sud, for example, having three branches in the northern part of the city. The longest cross-city line, No. 4, a north and south line, is 11.4 km. The total length of the circular line, operated in two sections, is 23.2 km. The total length of the subways, all double-tracked, is just 100 km. As in our cities the tubes themselves are built and owned by the city, the operating company furnishing the equipment and the power houses.

Since the lines are only double-track there is no express service, but such service is hardly called for where the maximum length of line is only 6.6 miles, particularly since the great majority of passengers will ride only half the distance, i.e., from the outskirts to the center of the city or vice versa.

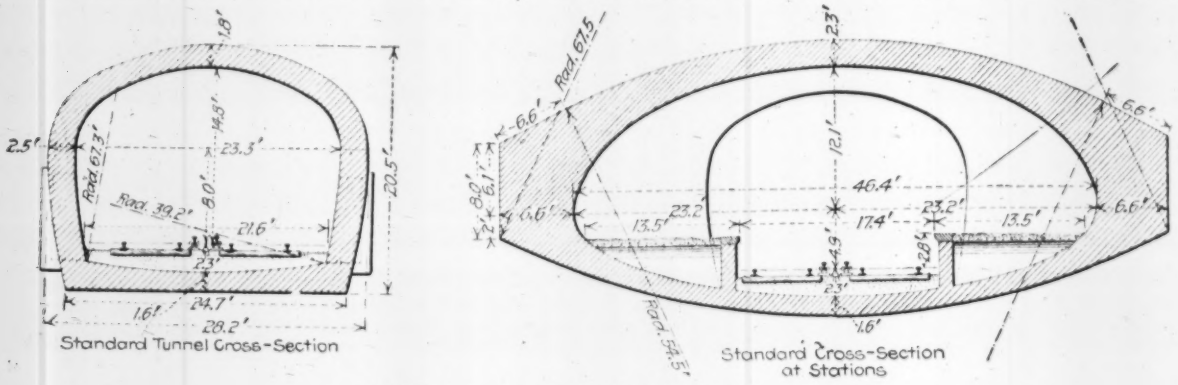
With the exception of parts of the circular line the system is entirely in tunnel, uniform cross-sections for tunnel and station, shown herewith, being used throughout.

The car arrangement differs from that of other cities in that in the second-class cars (there is one first-class and four second-class cars to a train) most of the space is devoted to standing room—a feature justified also by relatively short trips. In the second-class cars there are only 13 seats, while there is standing room for 108 people. On the other hand, the first-class cars provide 33 seats and standing room for 46 passengers.

Contrary to the practically universal rule in Europe, fares are on the flat, not the zone, basis. The second-class fare is 30 centimes (normally, about 6 cents) and the first-class fare 50 centimes (normally about 10 cents). Transfers are allowed in any direction without the payment of an extra fare. The present fares are 5 cm. more than the pre-war rates, and, as a result, there has been a slight reduction in traffic. The total revenue, however, has gone up.

Trains consist of five cars manned by a crew of four, a motorman and one guard in each of the first, third and last coaches. The guard in the center coach (first-class) has no other function than to see that none but holders of first-class tickets ride in that car. He punches the ticket as a check. The front and rear guards step to the platform when the train stops. The rear guard blows a whistle when all at this end have left or entered the cars, while a whistle blast from the front guard when his end is clear notifies the motorman to proceed. Doors are opened by the passengers themselves, but closed by the guards with an electric pneumatic mechanism. Admission to the station platform is controlled by a guard, generally a woman, who punches each ticket and, when a train pulls in during rush hours, closes a gate at the foot of the entrance stairway to prevent late arrivals from delaying the departure of the train by a last minute rush.

In general the service is quite satisfactory. The atmosphere is usually quite humid and, therefore, not very pleasant, the humidity being due, in large part at least, to the practice of constantly sprinkling the platforms to keep down the dust. So far as I know we have never in our subways found the dust nuisance serious.



STANDARD CROSS SECTIONS OF THE PARIS SUBWAY

The transfer connections between different routes are often exceedingly tortuous, and after threading them one is inclined to be more indulgent toward the horribly inconvenient Lexington Avenue-Forty-second Street and Seventh Avenue-Broadway connections at New York. No connection I found in Paris, though, was worse than either of these.

One feature is to be very highly commended—the excellent sign system. In this respect our own Boston-Cambridge subway is above criticism. At the entrance stairway of each station are two enameled signs giving in large white letters on a blue background the terminal station and the intermediate stations for the respective directions. Similar signs are found beyond the ticket booths, each appropriately placed at the proper stairway. On the station platform itself is a large sign with the name of the terminal station—this being more indicative than compass points because the lines run at every angle to the meridian. In addition in each car small enameled signs are found on the doors giving the name of each station in its proper geographical order, together with the name and number of the subways which intersect the line at transfer points. In many cases, also, a diagram of the line, with large lettering, is hung in the center of the car. A total stranger supplied with a pocket map can go anywhere by the subway system and find his way without asking questions. He can check up his progress by watching the car-door and the station signs.

Our subway operators may well copy the Paris subways in this respect.

Paris, June 17.

LETTERS TO THE EDITOR

Plight of Railway Technical Men

Sir—In a letter in your issue of Aug. 5, p. 279, by Walter J. Sykes, several pertinent inquiries are made in reference to the apparent oversight on the part of the Railway Labor Board in failing to consider the salaries of the railroad technical employees. Furthermore, Mr. Sykes raises the question why the 57 different engineering societies did not make an effort to look after the interest of their members employed by the railroads.

Shorn of all subterfuge, the Railway Labor Board did not provide for the railroad technical men as they were not properly organized along economic lines to present a case for their particular group. It is unfair to the other engineering societies to accuse them of dereliction, as they are not organized to look after the economic welfare of the members but are solely engaged in the promotion of technical education along engineering lines. Consequently, they are not in a position to discuss intelligently a question of wages and conditions, as was done by the representatives of the Brotherhood and the affiliated American Federation of Labor bodies.

This is as it should be. The old homily, "Let the shoemaker stick to his last" holds good in this instance By all means let the technical men support their "technical" societies and "technical" publication in order to keep abreast of recent engineering methods, and if perchance he is interested in improving his material welfare, let him organize along trade union lines.

It is utterly impossible to blend these two objectives into one common organization and do justice to either. Let any bona fide technical society attempt it and it will immediately stultify its sphere of influence. The reason: In the engineering societies we have employer and employee meeting on common ground so far as educational work is concerned. Just presume what would happen at such a gathering if the question of wages and conditions were discussed.

If, therefore, the railroad technical men are actually concerned in making some substantial material progress as one will infer from the letter of Mr. Sykes, let them affiliate with some subordinate body of the American Federation of Labor. By so doing they will openly proclaim in unmistakable terms that they are dissatisfied with their present condition and are going after those things which make life worth while and will assure to them and their families the opportunity to live with some reasonable degree of comfort.

Washington, D. C. L. C. ROCLYN.

Rapid Progress in Stadia Work

Sir—I was very much interested in the article of H. R. Randall, published in *Engineering News-Record*, July 22, p. 150, giving some records of rapid progress on topographic surveys.

Our firm has the engineering work on the Toole County Irrigation District, and a part of the work consists in taking the topography on about 400,000 acres. As both the writer and the engineer who has charge of that part of the work for us have had considerable experience in stadia work we use that method. The lands being surveyed have a comparatively uniform slope, and there are no trees nor underbush. Stadia parties are made up of five men—transitmen, recorder and three rodmen. Automobiles are used to carry the parties to and from the field, and the instrument man and recorder from station to station. The lines of the Cadastral Survey are used as base lines. Elevations were first established with a Wye-level for a control line. These lines are from 4 to 6 miles apart. All the traverses are in closed circuits, the allowable limit of error in closures being 1 ft. in elevation for a complete circuit and 30 ft. in line and distance per mile. As only every other station is occupied it means that instruments must be kept in absolute adjustment, and the instrument man can make no mistake. When a circuit doesn't close within the allowable limit it must be rerun. All vertical angles are read to minutes, distances to the nearest 5 ft., angles to the nearest 5 minutes on the traverse and the nearest degree on side shots.

This work was begun last October and carried on until Dec. 15. During that time 60,000 acres were surveyed with two parties averaging about 480 acres per day per party; of course much time was lost on account of weather conditions, so probably an average of a thousand acres was surveyed for each day the parties worked. We now have four parties in the field, and we are averaging 20,000 acres per party per month, and have hopes of increasing it to 25,000 acres per month.

The largest area covered up to now in one day's work with one party is 1,920 acres. Nine hundred and three shots were taken, thirteen stations occupied, and a strip 6 mi. long by one-half mile wide was surveyed. The error in closure for elevation for the circuit was 0.79 ft. The party worked 7 hr. and 40 min. The tract surveyed had one "draw" about 2 miles long within it. Ralph V. Buckner, with our firm, was the instrument man in charge of the party when this record was made. We plotted this day's work and found that the tract had been exceptionally well covered. HENRY GERHARZ.

Shelby, Mont. President Gerharz-Jaqueth Eng. Co.

Building Fills With Spreader Car

Sir—Referring to the article on the use of a spreader car in building fills in *Engineering News-Record* of Aug. 12, p. 329, this method was very good for the specific case described. But probably it would be a failure if used as suggested for filling beyond the 7-ft. height, as it would be impossible to maintain track for uninterrupted service while lifting from one bench to another. Furthermore, throwing the track from one side to another is useless and a waste of effort, not only in track work but for the spreader crew, as the fill will roll down the side of the embankment from the high position of the track.

Some years ago in Kansas City we placed 500,000 cu.yd. of earth for a double track railway fill 30 ft. wide on top with 1 : 1 slopes. A work track on center line with dump cars and spreader handled the job very successfully. A track gang continually jacking track gave us uninterrupted track facilities. L. C. SCOTT.

Cleveland, Ohio.

Why Water-Power Reports By Engineers Are Generally Favorable

Sir—The letter of Robert E. Horton in the issue of Aug. 12, p. 326, interests me very much. I heartily approve Mr. Horton's explanation, and join him in protesting against such assertions as he mentions that engineers invariably make favorable reports, either on water power, or other projects.

It is true that some young and inexperienced engineers appear to feel that it is their duty to write a glowing account of a project upon which they are called to report. And, unfortunately, there are many prospective clients not too scrupulous to attempt to tell an engineer in advance what kind of a report to write. However, the engineer of experience and good judgment, and that applies to most of those who report for investment bankers and investors, will not permit a client even to attempt to tell him what kind of a report he shall write. In our business we are particular to advise a client in advance that we are just as likely to write an unfavorable report, condemning the project entirely, as to write one that will be favorable. We tell him that the idea of a report is that we are to study the project and ascertain whether it is sound for financing or not, and then to set forth our findings in a clear and conclusive way so that others may understand it from perusal of our report. We do not know upon taking up a project, nor until the study is completed, what the conditions may be surrounding

the project. The appearances may be good but no conservative engineer will pronounce on any technical project without scientific investigation.

If a project is not sound and the engineers' report demonstrates the fact conclusively, the promoter should be glad to pay the fee to find that out, as it will probably prove to be the best money that could be spent on the project. That fee may save him thousands of dollars useless expenditure and wasted effort. Promoters are loath to take this view but the engineer should make this clear before undertaking to report.

It is the true explanation, that Mr. Horton advances, that unfavorable reports never see the light, and that is why thoughtless persons assume engineers always report favorably.

Speaking of water powers, one of the most difficult things to get a client to recognize, and indeed it may be said, to get the average engineer to consider, is that suitable physical conditions alone are not sufficient. They always begin by telling us about the wonderful gorge where the dam can be built and the great amount of water and the rocky formation, all of which may be quite good. But, they seem to ignore the very important fact that if this site is, as too often happens, far remote from commercial centers, the cost of delivering the power to market may be so great as to nullify the whole undertaking. We have a case of this description in our office at the present moment, the physical conditions for a hydro-electric installation being ideal. The cost, however, of a transmission system to deliver the moderate amount of power obtainable to a possible market would be so great that the revenues would hardly carry interest and depreciation on the investment for the transmission system, to say nothing of the cost of dam and station.

In other words, engineers need to regard a hydro-electric project more from the standpoint of an industrial undertaking, or a business, than from the point of view of an interesting construction job.

W. K. PALMER,
Kansas City, Mo. Consulting Engineer.

Paving Cost Comparisons

Sir—My attention has been called to an error in a table of costs of paving in your issue of July 8, p. 76. The cost per square yard for complete asphalt pavement in Washington should have been $5.06 instead of $6.26, and the per cent increase over Chicago 21.9, instead of 50.8 per cent.

JULIUS G. GABELMAN,
Chicago. Chief Street Engineer,
Board of Local Improvements.

Reducing Impact Factors for Dead-Load Ratio: A New Formula

Sir—In *Engineering News-Record* of April 29, 1920, p. 874, I was interested to see an article on an impact formula applicable to ballasted and concrete girders. In this connection, I have been recently carrying out some investigation work and from the results obtained I consider that a factor dependent on the ratio of the dead to live loads should be included in the formula for impact allowance for all spans above 120 ft. This would give much more rational and correct results than the formulas now in use, which are dependent only on the loaded length of span.

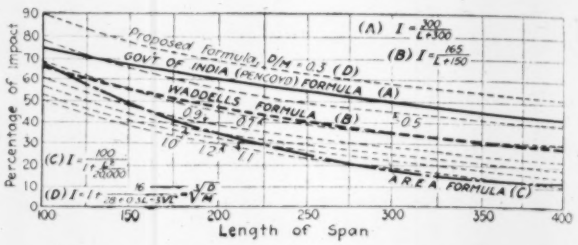
I have recently submitted a proposal to the Indian Railway Bridge Committee (the latter has been formed by the Railway Board of the government of India to investigate and consider the revision of the existing bridge rules, specially that of impact allowance), for a new formula based on the ratio of dead to live loads and loaded length of structures above 120 ft. in length. The diagram attached shows the new formula, which is,

$$I = \left(1 + \frac{16}{28 + 0.3L - 3\sqrt{L}} - \sqrt[3]{\frac{D}{M}}\right)$$

where

I = amount to be added to allow for impact
L = loaded length, in feet
D = dead load of the structure, ballast, permanent way, etc., taken on a length L
M = equivalent uniform live load of train, taken over a length L

There are also graphed on the same diagram the Pencoyd areas, and Waddell impact formulas.



VARIATION OF IMPACT WITH SPAN LENGTH, AND EFFECT OF DEAD-LOAD RATIO

Concerning the tests made by the bridge staff of the North Western Ry., I might say that in an open-deck truss of 120 ft., weighing 96 tons, with a train load of 250 tons, the difference in stress induced between static loading (the train at rest in a position giving maximum stress) and train traveling at critical speed has been found to be from 25 per cent to 30 per cent, whereas in the case of girders of the through type with cross-girders and ballasted floor, weighing 150 tons, and the same length and live loading as the above, the difference is only 12 per cent. The government of India bridge rules provide for the same increment for impact in each type of span.

In the case of the double-track bridge, length of each span 200 ft. clear, across the Jamna River near Saharanpur, the deflection taken under the static loading with two trains on a span was 0.75 in., while with the same trains running over the bridge in the same direction at a critical speed of 30 miles an hour the deflection at the center was 0.825 in., approximately 10 per cent greater than under static loading. The ratio of the dead load of the structure to the live is 0.59. In the Sara bridge, with spans 350 ft., the difference in deflection between static and moving loads is very small, less than 5 per cent. The ratio of the structure load to the live is 0.96.

If a formula similar to the one suggested were adopted on the North Western Ry. it would mean that existing large bridges which are of a through type with heavily ballasted floors, such as the Kotri Bridge, with 350-ft. spans, the Attock Bridge, with 308-ft. spans, the Adamwahan Bridge, with 257-ft. spans, and the Ferozepore Bridge, with 155-ft. spans, would be permitted to carry train loads 25 per cent greater than they are able to do at present, without much alteration or strengthening except to the floor systems and bracings.

W. T. EVERALL,
Lahore, India. Bridge Engineer, North Western Ry.

Shrinkage of Earthwork

Sir—I have read with interest the article on "Shrinkage of Loosely Filled Earthwork in Embankment," by E. E. R. Tratman, in *Engineering News-Record* of June 24, 1920. In this article reference is made to the brief which the Public Utilities Commission of Illinois filed with the Interstate Commerce Commission in connection with the valuation of the property in Illinois of the Elgin, Joliet & Eastern Ry. Co. This brief deals with various valuation questions and contains a somewhat detailed discussion of shrinkage, based upon an exhaustive survey of the available literature on the subject.

In the valuation of the Elgin, Joliet & Eastern Ry., as in many others prepared by the Division of Valuation, Interstate Commerce Commission, an allowance of 10 per cent of grading quantities was made for so-called shrinkage,

aning thereby the decrease in the volume of a settled bankment from the volume occupied in the original bed. this general allowance the Illinois Commission entered igorous protest, claiming there was no proof of its existnce and that until such proof was forthcoming no allowance therefor should be made.

The research undertaken by me made plain the utter confusion that exists in the engineering profession concerning shrinkage, involving serious disagreement as to the amount or even its existence. This may be readily accounted for by the incongruity of the results obtained by various investigators and the far-reaching influence of the statements of Ellwood Morris made more than three-quarters of a century ago when railroads were in their infancy.

The shrinkage of earthwork, as herein contemplated, is contrary to my own experience on heavy sewer construction work, and nowhere can I find reliable experimental data to back up the statements in various textbooks and engineers' handbooks that shrinkage exists. Practically all of these statements appear to be based upon the Morris experiments.

Under present procedure of the Interstate Commerce Commission allowances for shrinkage of earthwork upon the railroads in the United States will aggregate an enormous sum, and I cannot bring myself to believe that such allowances should be made without unquestionable proof of their justice. So far as I have knowledge this proof has not been furnished. If shrinkage exists and its amount can be determined I believe the carriers are entitled to a proper allowance therefor, but I insist that proof of its justice must first be furnished.

I am in full accord with the suggestions in Mr. Tratman's article that action looking to the solution of the problem should be taken, and because of the importance of the matter I am of the opinion that the American Society of Civil Engineers could with profit undertake an impartial investigation of the whole matter. Academic discussions are fruitless, and attempts to settle the matter by measurements of existing embankments are worthless.

May the publicity you have given the matter result in research that will lead to the final determination of the dispute.

Chicago. WALTER A. SHAW,
Commissioner, Public Utilities
Commission of Illinois.

Sir—In the letters of Messrs. Tripp and Ferry in *Engineering News-Record*, Aug. 12 and 19, are given data concerning the shrinkage of the earth in embankments, intended to contradict my statements in the issue of July 15, while they are adding proofs in support of my assertions. The facts ascertained by Mr. Ferry are very useful and interesting, on account of his having furnished positive data concerning this vexed question; and instead of relying all the time on abstract reasoning we have some correct measurements on which to base our discussion.

Mr. Ferry claims to have proven in the most convincing manner the shrinkage of the earth in the embankments, because by measuring correctly the one he built for the "Yale Bowl" he ascertained a decrease of 7 per cent in volume when compared with the cut. But in explaining the process of construction he says the distance of hauling never was over 100 feet, the loss in transportation was therefore negligible. In moving loose earth for a distance of nearly 100 feet by means of drag scrapers a great deal is lost in transportation, and it is not a negligible quantity indeed. Everyone has seen the earth falling out of the scrapers from the irregular pulling of the horses, and from the undulations of the surface ground which is not so smooth as a billard table, causing at every instance the fall of some material from the scrapers. Consequently the loss neglected by Mr. Ferry will certainly amount to 3 or 4 per cent at the very least.

Mr. Ferry has failed to notice the quantity of earth placed in the embankment, which was carried away by water. The "Yale Bowl," like Rome, was not built in a day, and before it was completed the embankment must have seen many rainy days and severe storms, and on each of these occasions, a large quantity of freshly deposited earth must have been washed away. None has been able so far to measure correctly such a quantity, but it is generally admitted that it is a great deal larger than what is lost in transportation.

Concerning the statement of Mr. Tripp, that he employed 115 cu.yd. to fill in a space of 100 cu.yd., although the data are very undetermined: This may give some light in regard to the losses in transportation. Notwithstanding the fact that Mr. Tripp has not given any information about the method used in measuring the 115 cu.yd. required for the fill, the means of transportation employed and the distance of hauling we may suppose that the earth was moved by ordinary carts, and the distance of hauling much greater than at Yale. Assuming, however, with Mr. Ferry the "earth shrinkage" of 7 per cent, the difference of 8 per cent must have certainly been lost in transportation.

Since the quantity of earth washed away from freshly constructed embankments is greater than the quantity lost in the ordinary transportation; thus at the "Yale Bowl" more than 8 per cent of the earth was carried away by erosion. Coming down to figures; if, at the "Yale Bowl" the loss on account of erosion was only 8 per cent, added to the minimum of 3 per cent lost in transportation, we have a total loss of 11 per cent (but Mr. Ferry has carefully measured a decrease in the embankment of only 7 per cent compared with the cut), there is an increase of 4 per cent, which proves my contention that the earth does not shrink but, if finally found of smaller volume in the embankment than in the cut, it is due to the losses in transportation and by erosion.

The embankment at Yale, notwithstanding it was so well constructed, settled for an average of ¼ of an inch, and the settlement was noticeable after two years, while no mention is made of any settling in the natural bank; this seems in contradiction with the statement that the material was more loose in its natural position than in the embankment. The settlement of the embankment is explained by the presence of voids which have been greatly reduced by sprinkling and rolling the deposited earth, voids that are not so numerous in the earth in its natural position. There are soils that are very loose, but Mr. Ferry would have certainly discarded them in the construction of the embankment for the "Yale Bowl." The additional evidence he gives further to demonstrate the shrinkage of the earth by comparing the consistency of the material in the natural position and in the embankment, by the effort required in driving stakes, is too empirical. It reminds one of a patent granted in 1915 by a South American Republic to an inventor of a new method of reinforcing concrete. Among the sworn statements the inventor claimed to have constructed slabs of reinforced concrete of every variety in existence, and with a sledge hammer to have smashed every one except his own. No engineer would be satisfied with such an athletic performance, and yet it passed the examination of the "experts" and the patent was granted. The cohesive force of the earth should have been determined in a more scientific manner to be considered as a proof of shrinkage.

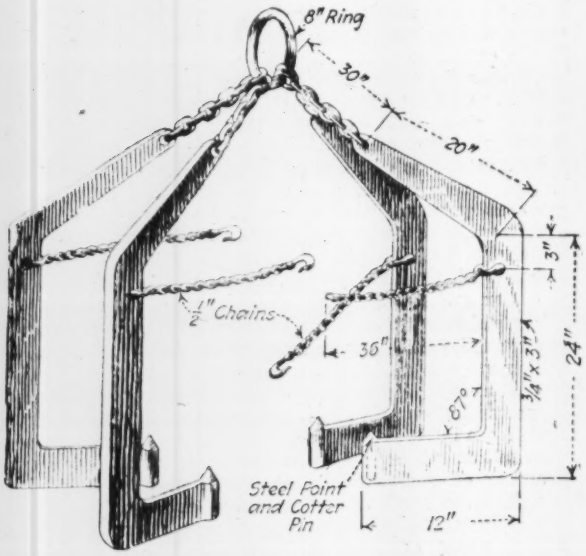
In conclusion the decrease of volume of the embankment at Yale as compared with the one measured in place is due: (1) To the losses in transportation which have been neglected by Mr. Ferry; (2) to the quantity of material carried away by erosion, which is greater than 8 per cent. But neither Mr. Ferry nor anybody else has been able to measure correctly. These two quantities added to the volume of the embankment would give a total quantity larger than measured in place, which will prove my assertion that the earth in the embankment (including the dispersed quantities) is always found of larger volume than in the cut, or in other words the earth does not shrink.

New York City. CHARLES PRELINI.

HINTS FOR THE CONTRACTOR

Four-Point Grab for Handling Large Rocks Superior to Tongs

EIGHT-TON rocks have been handled by a four-point grab, which has been found superior to tongs, at the pits of the Cornwall Ore Bank Co., Cornwall, Pa. As described by H. H. Hunner, in *Engineering and Mining Journal*, July 17, 1920, p. 117, this grab is easy to make, convenient for two men to handle, and is quickly attached to irregular chunks lying at random in a pile. Four times out of five it will release itself when the chunk is deposited on the stockpile. The



GRAB FOR HANDLING LARGE ROCKS

material for the legs is ¾ x 3 in., but Mr. Hunner recommends using ⅞ x 3 in., or 1 x 3 in., when the apparatus is designed to handle chunks weighing more than seven tons, as hooks of the size shown in the figure have in practice required to be straightened out once or twice. The lower chains, three of which have hooks on the end, are pulled up snug and cross-tied after the legs are worked under the chunk at points convenient to get at. On round chunks, three legs are usually sufficient to make a lift, but in moving long slabs the four points of support are necessary.

Wood Panel Paving for Track Crossings in Removable Units

AS AN improvement upon ordinary plank paving at track intersections on public highways the Wilkes-Barre Ry., of Wilkes-Barre, Pa., is using removable unit panels. A four-sided frame of the proper size and angle is built of 3 x ⅜-in. Z-bars, welded together at the corners, the bottom flanges being inward and having welded to them lugs which rest on the knee braces at the corners of the track crossing. This frame is filled with transverse wood strips 3 x 3 in., which rest on the Z-bar flanges and are nailed together, a wedge-shaped strip being driven at the middle of the panel to make a tight fit. The panel is given a brush coat of preservative and the exposed flanges of the Z-bars are roughened by means of a welding torch so that horses will not slip. When track maintenance or repair work has to be done at the crossing the panel is readily removed and replaced. According to the ELECTRIC RAILWAY JOURNAL some of these panels have been in use for five years at crossings of steam and electric lines on highways having heavy motor truck traffic.

Essentials of a Rental Contract

ALTHOUGH some contractors are committed to a policy of not renting idle equipment because of careless handling it may receive at the hands of the lessee, excessive depreciation may be even exceeded by storage, interest and taxes. The conditions of a lease will be capable of determining whether the transaction entails profit or loss. A number of contingencies, frequently escaping notice, are set forth in the following essential provisions recommended by the committee on methods of the Associated General Contractors of America:

1. Description of equipment.
2. Identification.
3. Proposed use.
4. Where to be used.
5. Circumstances and method of transportation.
6. By whom transportation charges are to be paid.
7. Date and duration of the rental period.
8. Responsibility of lessee covering theft and other circumstances from the time equipment leaves lessor's yards until returned.
9. Payment of fire insurance by the lessor.
10. Payment of liability insurance by the lessee.
11. Security of the lessee.
12. Protection of lessor by lessee against all damages through use of equipment.
13. Date shipment is to be made.
14. Notice of release of equipment.
15. Maintenance of equipment by lessee and return of equipment by lessee in its original condition less usual wear and tear.
16. Approval of operator by lessor.
17. Payment of traveling expenses and wages of operator by lessee if operator is furnished by lessor.
18. Payment of inspection by lessee if machine proves satisfactory, payment by lessor if machine is unsatisfactory. Statement determining who shall make inspection.
19. Number of shifts upon which his lease is based. Payment of 50 per cent more for double shift.
20. Provision for payment by the tenth day of each month for work of preceding month.
21. Engineer's estimates basis of rental rates per unit.
22. Optional purchase clause where desired, clause to state per cent of rental which may apply on purchase price, difference to be paid by lessee within certain number of days.
23. Retention of title by lessor.
24. Payment for loading and unloading at lessor's yards by lessor.
25. Right of lessor to inspect without becoming trespasser.
26. Failure in payment giving lessor right to take possession of machine without becoming trespasser.

NEWS OF THE WEEK

New York, September 2, 1920

Civil Engineers' "Proceedings" Sharply Curtailed

With the August number of the *Proceedings* of the American Society of Civil Engineers, issued during the past week, a far-reaching change in the publications of the Society has been initiated. Papers and discussions will no longer be published in *Proceedings*. The Publication Committee announces that it "has decided to omit the publication of formal papers (except in the case of short and timely papers of wide general interest, and reports of special committees) and discussions thereon, as well as memoirs. In place of the papers, synopses only will appear in *Proceeedings*, but the complete papers and subsequently the discussion thereon will be published in pamphlet form for distribution to such members as signify their desire for them. A suitable blank is printed on a perforated page at the end of *Proceedings* for use of members in ordering copies of papers and discussions. Heavily increased publication costs are the reason for the change. Besides papers and discussions, the retrenchment policy has eliminated the section of notices of new books, the index of current engineering literature, and memoirs of deceased members.

The change made is of particular significance, because the publication of papers and discussions has been one of the principal means of developing technical discussion in the society to its consistently maintained high standard. The committee invites suggestions on increasing the revenues and changing *Proceedings* still further. It asks whether the size of the publication shall be increased to 9 x 12 in., whether the policy of accepting advertising shall be adopted, whether editorial comment, reports of engineering research and publication of employment notices shall be added to the matter now contained in *Proceedings*. Concerning these matters the committee states that it did not wish to enter into experiment on its own judgment but "decided to adopt only conservative and reliable methods of securing economy, and proceed cautiously with more radical changes in *Proceedings*."

State of Maryland Purchases Road Commission Bonds

The Maryland State Roads Commission will have money available for road construction through the recent decision of the State Department of Public Works to invest in $1,000,000 worth of the roads commission's 1920 bonds. The bonds will be bought at par for the benefit of the sinking fund.

Associated Contractors' Headquarters Transferred to Washington

Effective Sept. 1, the headquarters of the Association of General Contractors was transferred from Chicago to Washington. The work of the organization will be expanded. The program for this expansion is now being prepared and will be announced in the near future. A branch office of the association will be maintained in Chicago. Washington will be headquarters of both Gen. R. C. Marshall, Jr., general manager, and Col. William Couper, assistant general manager.

Government Dredging May Be Stopped by Coal Shortage

Dredging operations being conducted by the Corps of Engineers are at the point of having to suspend, due to lack of coal. Gen. Harry Taylor, assistant to the Chief of Engineers, has returned from a trip to the coast during which he investigated the problem. The situation is worst at Norfolk and Philadelphia. It happens that the dredges at these ports are working within sight of thousands of cars of coal held on sidings. Contractors are being forced to pay $15 to $18 a ton for such coal as they can secure. Since fuel represents one-fourth of the total expense of dredging operations, General Taylor calls attention to the results which this is certain to have on the cost of work.

Winter Movement of Road Materials for 1921 Projects Planned

Reports to the Bureau of Public Roads indicate that the policy is becoming general to transport road materials before the contract is let. With the bulk of the materials on the ground, it is found that much more satisfactory bids can be obtained. In carrying out this policy, a number of states have reported definite plans to transport materials throughout the winter and spring to the extent that transportation may be available.

Ordinarily, 85 per cent of the highway work in the United States is suspended with the advent of cold weather. Reports reaching the Bureau of Public Roads indicate that much more road work will be done this winter than ever before, due to the determination of most of the Southern states to push road-building operations throughout the winter. Labor is more plentiful in the South during the winter months and it is believed that sufficient cars can be secured to keep most of the projects going.

Colorado River Regulation and Utilization

League of Southwest Considers Subject at Annual Meeting—Address by Arthur P. Davis

Reported by A. Lincoln Fellows, Senior Irrigation Engineer, U. S. Department of Agriculture, Denver, Col.

Upon invitation of the Governor of Colorado, the League of the Southwest, comprising the states drained in part by the Colorado River and its tributaries, met at Denver on Aug. 25 to 27 for the further consideration of plans for work in connection with the proposed regulation and utilization of the waters of the Colorado River basin, mentioned in *Engineering News-Record*, Aug. 19, p. 380. There were present the governors of Arizona, Utah and Colorado and representatives of the governors of Wyoming, New Mexico, Nevada and California—those seven states making up the league—and the state engineers of several of the states and others interested in the subjects under consideration. Governor Thomas E. Campbell of Arizona acted as chairman throughout the sessions.

The outstanding features of the meeting were the addresses of Arthur P. Davis, Director of the U. S. Reclamation Service, Ex-Gov. E. M. Ammons of Colorado, and Frank C. Emerson, State Engineer of Wyoming. Mr. Davis spoke particularly of the problems involved, irrigation possibilities, power development and flood regulation. He stated it to be his opinion, based on a study of the Colorado River covering some thirty years, that, generally speaking, there need be no apprehension as to restriction of development along any lines, either in the headwaters or in the lower valleys, provided that the main regulating reservoir is located in the lower part of the basin, since the water supply, adequately regulated, would be sufficient for the needs of all. He also said that the investigations at Boulder dam-site, mentioned in the article to which reference has been made, were by no means complete and it was impossible as yet to say whether this was the best site or not, or whether it was even feasible, but that sufficient investigation should be made to demonstrate what was really the best plan to be followed. It was shown that it was possible to irrigate several millions of acres in addition to what is now irrigated, and at the same time furnish the necessary protection from floods to the Imperial Valley, while in no way impeding development to the greatest practicable extent of the power possibilities on the

headwaters, amounting to millions of electrical horsepower. An especially important point brought out later in discussions was that interstate litigation was more likely to result without than with such regulation. Former Governor Ammons and State Engineer Emerson agreed with Mr. Davis as to the importance of regulation and the protection of the Imperial Valley but urged that every precaution be taken against the possibility of interfering in any way with the work of developing the resources higher up on the streams.

In general the discussions were marked by a spirit of harmony and the resolutions presented by the Resolutions Committee were passed without a dissenting voice. These resolutions favored in brief: (1) The policies set forth in previous meetings of the League. (2) Full development of the resources of the Colorado River Basin, in view of the statements made by Director Davis, due care being taken that no storage project on the lower stream should be permitted to jeopardize those on the tributaries. (3) The formation of a Colorado River Engineering Commission made up of the state engineers, or officers having equivalent positions, of the seven states immediately affected, and the Director and Chief Engineer of the Reclamation Service, this Commission to meet from time to time to consider the engineering problems presented. (4) Appropriation by Congress of the funds estimated by the Reclamation Service as necessary to make investigations sufficiently complete to warrant arrival at definite conclusions.

A report of the Ways and Means Committee was also made and approved, the most important feature of which was the acceptance of offices for headquarters in the Capitol of Arizona at Phoenix and the selection of Sims Ely, secretary, Resources Board, as executive secretary of the League.

The meeting adjourned, subject to call at a time and place to be determined by the executive committee.

Public Roads Head Sees Danger in Federal Appropriation Lapse

Unless Federal action is taken during the current fiscal year concerning Federal aid in road building, the resulting uncertainty as to the future of this work will seriously handicap the states and cause the entire road-building program to suffer a serious setback, according to Thomas H. MacDonald, chief of the Bureau of Public Roads. In discussing the need of Federal action this year, Mr. MacDonald points out that the last installments of Federal aid funds—$100,000,000—became available July 1, 1920. When to this is added at least an equal amount of state funds, as required by law if states are to secure Federal aid, funds will be available sufficient to carry the road construction program forward for the current year. But Mr. MacDonald points out that the states should know at least a year in advance what funds are to be available in order that plans can be made for future construction.

Since, in the past five years, highway departments have accustomed themselves to planning and executing extensive programs, partly through availability of Federal funds, a lapse in Federal appropriations might result seriously, is Mr. MacDonald's view.

Technical Institute To Be Founded by Ford Company

An educational department is to be established by the Ford Motor Co., to be known as the Ford Technical Institute, with university rank, to grant degrees in mechanical, electrical, and chemical engineering, according to announcement made in Detroit, Aug. 26.

It is planned to make complete courses available to the more than 75,000 employees of the Ford company without charge. An academic department will be established and complete laboratories will be provided, according to the announcement.

Rail Executives Ask Additional Construction Funds

Additional funds for construction are included in the revised and final report of the Association of Railway Executives to the Interstate Commerce Commission embracing recommendations as to the apportionment of the $300,000,000 revolving fund established by the Transportation Act to aid in the rehabilitation of the railroads.

New recommendations make provision for the following work:

Baltimore & Ohio Co., additional main tracks, yard tracks, sidings, interlockers, telephone train dispatching, shop machinery, bridges, trestles, culverts, heavier rail, $5,000,000.

Boston & Maine, retaining walls and riprapping, renewal of bridges, automatic signals, extensions to sidings, interlockers, improved water supply, engine house and yard facilities, $2,188,564.

Chicago & Eastern Illinois, shop machinery, improvements to trestles, $502,060.

Chicago Junction Railway, yards and car shop, $1,100,000.

Chicago, Milwaukee & St. Paul, ballast, rail, bridges, yard tracks and sidings, fuel stations, water stations, shop buildings, shop machinery and tools, track elevations, $4,940,000.

Chicago, Rock Island & Pacific Railway, additional yard tracks and sidings, shop machinery and tools, ballast, bank widening rails, bridges, $5,000,000.

Missouri Pacific Railroad, rails, bridges, trestles, additional yard tracks, signals and interlockers, telegraph and telephone lines, fuel and water stations, shop buildings, engine houses, shop machinery, tools, wharves, and docks $2 843,179.

New York Central Lines — Allocated as follows: New York Central (including Boston and Albany) Railroad, $12 101 928. Engine terminals and facilities, freight yards and yard facilities, sidings and extensions, interlockers, shop machinery and miscellaneous betterments, $5,500,000.

Cleveland, Cincinnati, Chicago and St. Louis, double tracking, passing and storage tracks, shop tools, machinery and signals, $4,560,101.

These, and other minor projects, increase the total outlay from the revolving fund for construction purposes from $35,050,289 to $78,349,289. The preliminary report of the Association of Railway Executives was submitted to the Interstate Commerce Commission June 26.

Engineering Foundation Solicits Gifts

A general appeal, for donations is being issued by the Engineering Foundation with a view to increasing its fund for the support of research in science and engineering. At present the Foundation has a fund of $300,000 with assurance of $250,000 more. However, it wishes to increase this fund to at least $1,000,000. The appeal says, "The first million should be rounded out this year and other millions should follow."

The United Engineering Society is the custodian of the principal of the Foundation endowment, but the income is administered by the Foundation itself. Charles F. Rand, chairman of the Foundation, states that gifts of $1.000 or more are desired, and that each person giving $250,000 or more will be honored as a Founder.

Work done by the Foundation up to the present includes initiating and investigation of fatigue phenomena of metals (now in progress), financing a hydraulic research for the development of an improved type of measuring weir, participating in a study of spray camouflage of ships, supporting a study of mental hygiene of industry, and supporting a research into the wear of gears.

Notes from the Corps of Engineers

Col. Spencer Crosby, in addition to his duties as division engineer of the southeastern division, will take over temporarily the work of the Jacksonville district.

Col. Edward H. Schulz, who has been in charge of the Milwaukee district, has been ordered to take over the Seattle district.

Lt.-Col. J. A. Woodruff, who has been in charge of the Seattle district, has been ordered to Camp Humphreys for duty at the Engineer School.

Col. Lytle Brown, now at Florence, Ala., has been ordered to Camp Travis, Tex., to take command of the second engineers. In order to comply with the provisions of the Army Reorganization Act that officers must have at least one year out of five with troops, many of the more experienced officers of the Corps of Engineers are being assigned to commands at camps. This is having the effect of adding materially to the dearth of engineer officers. The extent of this situation may be judged by a concrete instance. Col. Fred W. Alstaetter, in charge of the Savannah district, was retired last week on account of physical disability, but it was necessary to call him to active duty the following day because there was no officer to put in his place.

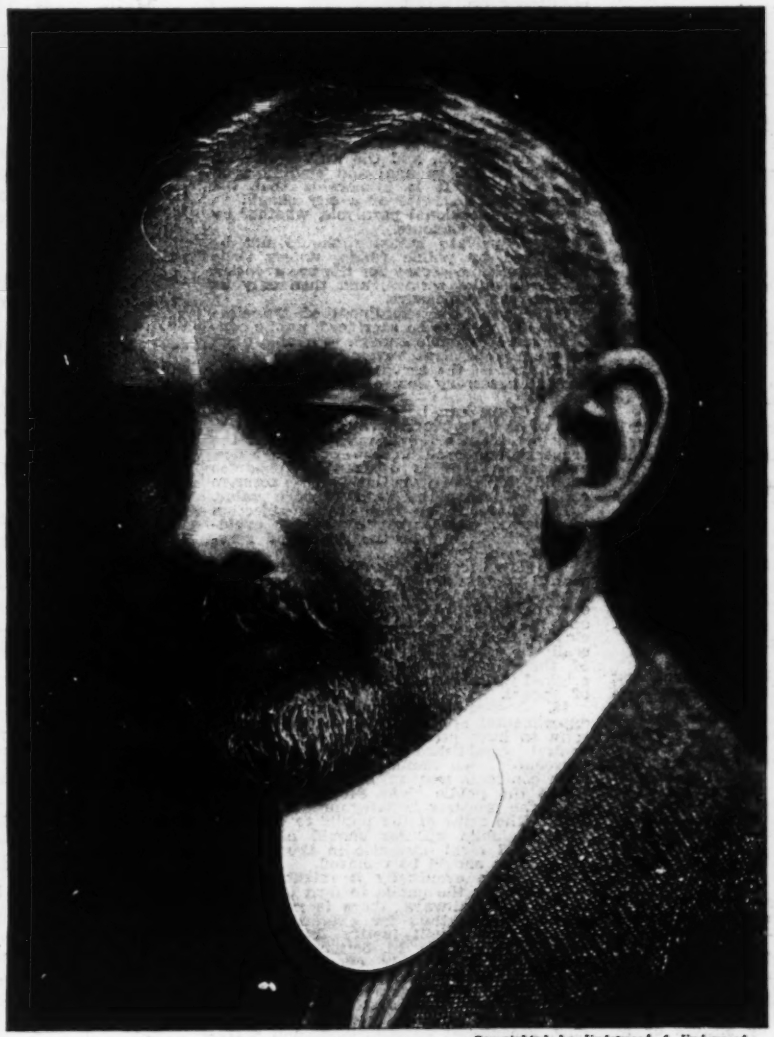
With the abolition of the old military departments and the substitution of "corps areas," the title of department engineer is dropped and the engineer officer in the same relative position now will be known as "corps area engineer."

Charles Whiting Baker to Develop New Field

Leaves Editorial Desk After Brilliant Journalistic Career—Will Direct Engineering Business Exchange

Charles Whiting Baker, Consulting Editor of *Engineering News-Record* retires from technical journalism on Sept. 1, 1920, to take up the development of a new engineering service. This step brings to a close a notable career as editor and engineering writer. Mr. Baker has been identified with the field he now leaves during substantially his entire technical career, and since succeeding Arthur M. Wellington as editor of *Engineering News* in 1895 he has been known throughout the technical world as a leader in engineering thought. The thorough knowledge of professional work and the wide personal acquaintance with engineers acquired in the course of his editorial career promise to find effective application in the new field of labor he enters, development of the Engineering Business Exchange.

Outlining the work of the new service, of which he becomes Managing Director, Mr. Baker states that under present conditions many a professional or industrial business in the engineering field becomes unprofitable or is sold at a loss of value because means are wanting for finding the right man to take it over and build it up to large success. On the other hand, men able to carry responsibility in the ownership or direction of an engineering business continue to work in subordinate capacity in an organization holding little promise for them. It is to establish an agency through which the two classes of parties can come together under full assurance of competent guardianship of their several interests that the Engineering Business Exchange has been organized.



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CHARLES WHITING BAKER

"C. W.," as he is familiarly known among his colleagues of the fountain pen and the copy basket, has been connected throughout his editorial career with *Engineering News-Record* and its predecessor, *Engineering News*. His inborn instincts for journalism drew him into the work almost immediately at the end of his college period. It was his writing of a number of technical articles for *Engineering News* while studying at the University of Vermont that induced the late George H. Frost, its publisher, to offer him a position on the editorial staff immediately after his graduation in 1886. Instead of accepting this position, however, he went to the Baldwin Locomotive Works, but within a year, Mr. Frost's offer being repeated, he accepted it and became assistant to the noted Arthur Mellen Wellington, who had assumed the editorship of the paper a short time before.

Matching the restless activity of his chief with his own high-pressure style of working, "C. W." rapidly made himself an integral part of the *News* machine, so that it was a logical happening when upon Mr. Wellington's death eight years later the youthful assistant was called to succeed him. Together with D. McN. Stauffer, Frederic P. Burt, M. N. Baker, and a group of junior colleagues, he continued the development of the paper initiated by Wellington. In 1911, when Mr. Frost, wishing to retire, transferred his journal to John A. Hill, Mr. Baker performed in remarkably short time the difficult task of transforming *Engineering News* so as to adapt it to the specialized requirements of the new group of technical journals which the paper had joined in the Hill Publishing Co. Five years later, when the Hill company and the McGraw Publishing Co. joined hands, Mr. Baker's long services were recognized by his promotion to the post of Consulting Editor to the new consolidated journal, *Engineering News-Record*. His elaborate special studies carried out in this connection have become widely known. The most recent are "The Railway Problem" and "What Is the Future of Inland Water Transportation?"

Although the absorbing character of the editorial vocation gives little time for other writing, Mr. Baker finds leisure for occasional literary and philosophic work. He is the author of a thoughtful study of one of the great economic problems of the country, published under the title "Monopolies and the People." In addition, he is also distinguished as an inventor, having devised and patented at different times a new steam separator, a steel wheelway for city streets, a new light railway system (the "Economic Railway"), and an improved oil engine. He has held a number of offices of public trust, and since 1913 has been a member of the Palisades Interstate Park Commission of New York and New Jersey. His election to the vice-presidency of the American Society of Mechanical Engineers, 1909-1911, was an incidental tribute to his long-continued work for the improvement of technical societies.

Report of Federal Electric Railway Commission

Restore Credit, Dewater Stock, Lift Pavement Burdens, Meet Extension Costs by Assessments

Acting on suggestions made by the Secretaries of Commerce and Labor, President Wilson appointed a Federal Electric Railway Commission on May 31, 1919, to investigate the street railway situation. The Commission, as suggested to the president, was composed of eight representatives of different organizations. The men chosen by the President, together with the organizations, were as follows:

Charles E. Elmquist, president and general solicitor of the National Association of Railway & Utilities Commissioners.

Edwin F. Sweet, Assistant Secretary of Commerce, representing the Department of Commerce.

Philip R. Gadsdon, representing the American Electric Railway Association.

Royal Meeker, Commissioner of Labor Statistics, Department of Labor, representing that Department.

Louis B. Wehle, general counsel of the War Finance Corporation, representing the Treasury Department.

Charles W. Beall, of Harris, Forbes & Company, New York, bankers, representing the Investment Bankers' Association of America.

William D. Mahon, president of Amalgamated Association of Street & Electric Railway Employees of America, representing that association.

George L. Baker, Mayor of Portland, Oregon, representing the American Cities' League of Mayors.

The report of the Commission, submitted July 28, and made public late in August is published in full in the *Electric Railway Journal* of Aug. 28. The conclusion and recommendations of the report follow:

1. The electric railway furnishing transportation upon rails is an essential public utility, and should have the sympathetic understanding and co-operation of the public if it is to continue to perform a useful public service.

2. The electric railway has been, and will continue to be, a public utility, subject to public control as to the extent and character of the service it renders, and as to the rates it charges for such service.

3. It is of the highest importance that both the total cost of the service and the cost to the individuals who use it shall be kept as low as possible without injustice to those who take part in producing it.

4. The electric railway industry as it now exists, is without financial credit, and is not properly performing its public function.

5. This condition is the result of early financial mismanagement and economic causes, accentuated by existing high price levels of labor and materials, and of the failure of the uniform unit fare of five cents, prescribed either by statute or by local franchise ordinances or contracts to provide the necessary revenues to pay operating costs and to maintain the property upon a reasonable basis.

6. The industry can be restored to a normal basis only by the introduction of economies in operation, improving its tracks, equipment and service, and securing a reasonable return upon the fair value of its property used in the public service when honestly and efficiently managed.

7. The electric railways must expand to meet the growing needs of their communities; therefore, the first essential is to restore credit in order to obtain necessary new capital for the extension and improvement of service.

8. Restoration of credit involves a readjustment of relations which will remove public antagonism, provide public co-operation, and insure to the investor the integrity of his investment and a fair rate of return thereon.

9. Effective public co-operation should be exercised by eliminating, in so far as it is practicable, special assessments for sprinkling, paving, and for the construction and maintenance of bridges which are used by the public for highway purposes.

10. Extensions into new territory resulting in special benefits to the property in that vicinity should be paid for by assessments on such property in proportion to the benefits received, and that the amount of such assessments should not be added to the physical value of the corporate property.

11. The great increase in the use of private automobiles, the jitney and motor buses, has introduced a serious, although not a fatal, competition to the electric railway. These forms of public motor conveyance when operated as public carriers, should properly be subject to equivalent regulatory provisions.

12. The full co-operation of labor is essential to the highest prosperity and the usefulness of the industry. The employees engaged in this occupation should have a living wage and humane hours of labor and working conditions. They should have the right to deal collectively with their employers, through committees or representatives of their own selection. All labor disputes should be settled voluntarily or by arbitration, and the award of such a board should be final and binding upon both parties. It is intolerable that the transportation service of a city should be subject to occasional paralysis, whether by strikes or by lockouts.

13. A private industry should not be subsidized by public funds, unless it is imperatively necessary for the preservation of an essential service, and then only as an emergency measure.

14. Unless the usefulness of the electric railways is to be sacrificed, public control must be flexible enough to enable them to secure sufficient revenues to pay the entire cost of the service rendered, including the necessary cost of both capital and labor.

15. There can be no satisfactory solution of the electric railway problem which does not include the fair valuation of the property employed in the public service, and where that is done, the companies should voluntarily reduce any excessive capitalization to the basis of such value.

16. There is no insuperable objection to a large, wideawake city having exclusive jurisdiction over the rates and services of public utilities.

17. The necessity for scientific and successful regulation of systems, whether large or small, and especially those which operate through several cities and villages and in rural territory, leads to the conclusion that local regulation should generally be subject to the superior authority of the State, whether as a matter of original jurisdiction or through the medium of appeal.

18. Cost-of-service contracts are in the experimental stage, but where tried, they seem to have secured a fair return upon capital, established credit, and effected reasonably satisfactory public service. Such contracts may safely be entered into where the public right eventually to acquire the property is safeguarded.

19. The right of the public to own and operate public utilities should be recognized, and legal obstacles in the way of its exercise should be removed.

20. While eventually it might become expedient for the public to own and operate electric railways, there is nothing in the experience thus far obtained in this country which will justify the assertion that it will result in better or cheaper service than privately operated utilities could afford if properly regulated.

21. Public ownership and operation of local transportation systems, whether or not it be considered ultimately desirable, is now, because of constitutional and statutory prohibitions, financial and legal obstacles, the present degree of responsibility of our local governments, and the state of public opinion, practicable in so few instances, that private ownership and operation must as a general rule be continued for an extended period.

22. If the reforms incident to public regulation which we suggest in this report should not result in making private ownership satisfactory to the public, such reforms should at least enable public ownership to be established upon a just and equitable basis.

Publicity Contest of A. A. E. Started Sept. 1.

The 1921 publicity contest of the American Association of Engineers during the period Sept. 1, 1920, to March 1, 1921, will duplicate the one held last year. The grand prize is a silver cup for the greatest number of column-inches of local newspaper publicity. The competition between chapters is divided into five divisions based on the population of the city in which the chapter is located. The five chapters winning division prizes (framed certificates of award) will compete for the grand prize on the basis of quality of publicity.

Move Started To Better Car Service in the West

Circular letters have been issued from the office of the General Manager of the Associated General Contractors of America inviting contractors, whether members of the association or not, to submit facts regarding their transportation needs. The circular letter requests specific notes upon the following points: Point of shipment, railroad over which material is to be shipped, point of delivery, type of car required, number of cars needed per day and total number of cars needed. Any additional information the contractor may wish to give may be included in the reply.

These circular letters are issued for the purpose of providing information to the various special car service committees consisting of representatives of the railroads and representatives of the leading contractors, manufacturers and dealers, recently formed to improve car service for construction interests in the territories served by the main railroad lines East of the Mississippi River. Inasmuch as Transportation Order 7, as modified by Order 9, granting priority to coal shipments, has been extended another thirty days to September 18 by the Interstate Commerce Commission, all co-operation possible is deemed necessary between railroad representatives and those of the construction industry to secure movement of construction materials.

Road Material Situation Becomes Worse in West

While transportation conditions, as affecting road materials, have improved east of the Mississippi River, the situation in the West has become so acute that the Bureau of Public Roads recently sent engineers to St. Louis to confer with representatives of the western carriers. So many open-top cars have been drawn east of the Mississippi that the shortage in the West is reported to have assumed as serious proportions as had been experienced in the East. Steps were taken looking to the return of cars and to provide for greater efficiency in the use of such cars as remained in the hands of western lines.

Devil's Gate Dam Undergoes Successful "Christening"

The highway over the Devil's Gate Dam, construction of which was described in *Engineering News-Record*, July 29, p. 202, was open to the public on Aug. 18. An engineer among the

crowd which attended the ceremonies states that "some 50 watermelons were broken on the bow by Little Miss Bent Brothers. It was one of the most successful christenings I ever saw."

Large Damage in Bridge Floor Fire Quickly Repaired

On Aug. 22 fire started in the wooden flooring of the vehicle roadway over the Victoria Bridge over the St. Lawrence River at Montreal, and the larger part of the decking on 14 spans was destroyed. To provide for vehicle traffic a temporary ferry service was established. The Grand Trunk Ry. officials started repairs at once and brought their full resources of material and labor supply to bear on the job. Late on Aug. 26 the roadway was again ready for traffic. The loss caused by the fire was appraised at about $300,000, most of which was in floor lumber, though some steel stringers also were damaged by the heat and had to be replaced.

Fall Meeting of The American Chemical Society

The general sessions of the Reconstruction Meeting of the American Chemical Society, which will be held in Chicago, Sept. 6 to 9, will include addresses by Thomas E. Wilson, president of Wilson & Co., Chicago, on "The Value of Technical Training in the Reconstruction of Industries," and by Prof. H. P. Talbot on "Relation of Educational Institutions to the Industries." The Division of Water, Sewage and Sanitation of the society also includes four articles as follows: A. S. Behrman, "Water Softening for the Manufacture of Raw Water Ice"; H. E. Jordan, "Specifications for Glass Ware for Water Works Laboratories"; W. D. Collins, "Hardness of Surface Waters in the United States," and Edward Bartow, "The New Sewage Testing Station of the Illinois State Water Survey Division. A fuels symposium, under the chairmanship of A. C. Fieldner, supervising chemist, Bureau of Mines, includes 12 papers on various phases of fuel supply, carbonization of coal, city gas supply and fuel conservation.

The headquarters of the society will be the Congress Hotel, Chicago.

A. A. E. Admits Founder Society Members Without References

The national executive committee of the American Association of Engineers has voted that applicants for membership who are members of one of the four national technical societies need not furnish five references as heretofore required. The action was taken as one means of reducing the duplication of society effort and on the request for such action by members of the technical societies who felt that further investigation of their records already on file was unnecessary.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Holyoke, Mass., Sept. 7-10.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

SOUTHWEST WATER WORKS ASSOCIATION, Waco, Tex.; New Orleans, La., Sept. 20-23.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA, Sterling, Ill.; St. Louis, Sept. 21-23.

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

The Colorado Society of Engineers will hold a convention Sept. 9, 10 and 11 coincident with meetings of the American Institute of Mining Engineers, the American Mining Congress, the International First Aid and Mine Rescue Meet and possibly other mining societies.

The San Francisco Section of Members, Am. Soc. C. E., at its bimonthly meeting, on Aug. 17, listened to a paper on "River and Harbor Improvements on the Pacific Coast" by Col. E. Eveleth Winslow, Corps of Engineers, U. S. A.

The Western States Reclamation Association held a convention at Boise, Idaho, Aug. 20-21, at which the speakers outlined the work the association had before it in putting through a program which will irrigate millions of acres of arid Western lands. Committees were appointed on finance, publicity and legislation. Plans for bringing the attention of Congress to the need of reclamation also were prepared. Most of the Western states were represented by their governors or accredited representatives.

The Southern California Section of Members, Am. Soc. C. E., at its meeting in Los Angeles, Aug. 2, was addressed by President Arthur P. Davis, who spoke on the work of the Committee on Development and the Joint Conference Committee and outlined the work of the American Society of Civil Engineers coming under his knowledge during his 28 years of membership. He pointed out "Service with Co-operation" as the proper keynote for the proposed Federation of American Engineering Societies. Mr. Hawgood reported on the progress of the Joint Committee's work on the constitution of the proposed State Engineering Council.

The Colorado Section of Members, Am. Soc. C. E. met, Aug. 26, at an informal dinner in Denver in honor of the president of the society, Arthur P. Davis, director of the U. S. Reclamation Service. An interesting feature was the presence, through general invitation, of members of the other Founder Societies and also of the American Association of Engineers and the Colorado Society of Engineers. President Davis forcefully presented the claims of the engineering profession to proper public recognition and urged upon all engineers the adoption of the principles of progressivism and co-operation. He especially advocated united action by all engineering societies; and in particular urged upon the members of the American Society of Civil Engineers that the strongest possible vote be cast in favor of the society's becoming one of the charter members of the recently organized Federated American Engineering Societies.

The North Carolina Society of Engineers, at its annual convention, held at Asheville, N. C., Aug. 12-14, appointed a special committee, composed of Charles E. Waddell, chairman, Asheville; H. W. Kueffner, city engineer of Durham; Curtis A. Mees, consulting engineer, Charlotte; Major E. W. Myers, hydraulic engineer, Greensboro; and Dr. W. C. Riddick, head of the state society and president of the A. & E. College, to draft a law making obligatory the licensing by the state of engineers and land surveyors, for presentation to the legislature. Announcement was made that the election of officers will take place at the meeting of the society at Raleigh next January. Plans were made, also, to redraft the constitution of the society so that it may be affiliated with the American Association of Engineers. The Thursday night gathering was featured by the presentation of a charter to the Asheville Chapter of the American Association of Engineers by Wythe M. Peyton, president of the newly formed chapter. The last day of the convention was given over to the entertainment of the guests, who were taken through the Biltmore estate and the Government Oteen Hospital.

PERSONAL NOTES

J. W. BEARDSLEY, of Rochester, N. Y., has been selected as the engineer member of a road commission of five members, appointed by the Panamian Government, which will have charge of a comprehensive road construction program to begin immediately. The work will cost about $7,000,000 and will require five years or more for completion.

THOMAS H. HEALY, until recently in the employ of the Philadelphia & Reading Railway Co., as roadway assistant engineer in its valuation department, in which capacity he had charge of roadway, and also the bridge and building inventory parties working

in conjunction with the Interstate Commerce Commission's field parties, is now in the service of New York Central Lines West, with the title of assistant engineer, compiling the reports required under Valuation Order No. 3. He has been assigned to the office of the division engineer of the Michigan division, with headquarters at Toledo.

W. H. RILEY, formerly in the drafting department of the American Bridge Co., Gary, Ind., is now in charge of the drafting department of the home office of W. Austin Smith, consulting engineer, at Huntington, W. Va. Mr. Smith is conducting a general municipal engineering practice covering parts of West Virginia, Kentucky and Ohio. The home office makes the general and detailed plans and all standard plans from data sent in from the field offices.

COL. ROBERT ISHAM RANDOLPH, secretary of Isham Randolph & Co., Chicago, is Republican candidate for trustee of the sanitary district of Chicago. Col. Randolph has been secretary of the Internal Improvement Commission of Illinois and of the Rivers and Lakes Commission of Illinois. During the war, as colonel, he organized the 535th Engineers at Camp Lee, took that regiment to France and served in the San Mihiel sector with the Second Army, A. E. F.

BRIG.-GEN. HENRY JERVEY has been assigned as director of the Operations Division of the General Staff of the War Department. Prior to his assignment to General Staff duties, General Jervey served in the Corps of Engineers.

KARL RIDDLE has resigned as resident engineer on a Federal Aid road project in Dickinson County, Kan., to accept a position as city manager of South Palm Beach, Fla. He has for several years been engineer of Dickinson County and city engineer of Abilene, Kan. He is a member of the firm of Riddle & Riddle, consulting engineers.

HARLAND BARTHOLOMEW announces the opening of new offices in the Compton Building, St. Louis, Mo., for professional practice in city planning and allied subjects. Mr. Bartholomew and his staff will give special attention to the preparation of city plans, zoning ordinances, park and playground designs, to land subdivision and special landscape problems. In addition to his new interest, Mr. Bartholomew will continue to serve as engineer to the City Plan Commission of St. Louis.

CAPT. H. M. GLEASON, Construction Corps, U. S. Navy, stationed at Mare Island Navy Yard, has resigned to accept the position of assistant to the president of the Chase Co., of Waterbury, Conn. Capt. Gleason entered the U. S. Naval Academy in 1895 and has served in the Navy ever since. He has been in charge of naval construction at Mare Island since Dec. 1, 1910, and during that period had immediate charge of the construction of 22 naval vessels and numerous smaller craft. Some of the ships constructed in this time are the battleship "California," the destroyer "Ward," with a world's record of 17½ days from the laying of keel to launching, and the electrically-driven fleet collier "Jupiter."

T. C. MORRIS has resigned as resident engineer, building division, Panama Canal, and is now associated with Lockwood, Greene & Co., as engineer in the Detroit office.

S. M. SMITH, recently principal assistant engineer of the Wabash Railway Co., has been appointed resident bridge engineer with the same company on the reconstruction of its draw span across the Rouge River at Detroit, Mich.

CHARLES WARREN HUNT became secretary emeritus of the American Society of Civil Engineers on July 28.

MAJOR W. J. POWELL has resigned as engineer of Dallas County, Texas.

FRED C. DUNLAP, chief of the Bureau of Highways, Philadelphia, has been placed in charge also of the city's street cleaning bureau, relieving John H. Neeson, assistant chief engineer of the Highway Bureau, who has been acting chief of the street cleaning bureau since the resignation of Lt.-Col. Earl B. Morden.

CAPT. A. H. SJOVALL, formerly in charge of engineering work at Camp Devens, has been made assistant city engineer of New Britain, Conn.

OBITUARY

PAUL B. REGNIER, engineer for the California State Highway Commission and sergeant in the 91st Division during the war, was drowned near Dunsmuir, Cal., Aug. 9.

WILLIAM W. FELLOWS, for many years chief engineer of the Bangor, Me., water-works, and member of the water board of that city, died Aug. 8 in that city. He was born in Bangor, Sept. 6, 1835. When the city water-works were built, in 1874, he assisted in the installation of the machinery, and was later made chief engineer. After concluding his active connection with the water-works, he was elected a member of the water board, serving from 1904 to 1907.

JOHN PERRY, emeritus professor of mechanics and mathematics at the Royal College of Science, South Kensington, England, died Aug. 4. He was born in Ulster, Feb. 14, 1850, and received his education at Queens College, Belfast. Professor Perry began his educational career as assistant master at Clifton College, followed by several years' residence in Japan as a professor of engineering, and was professor of engineering and mathematics at the City and Guilds of London Technical College, Finsbury, from 1881 to 18[illegible]. He was also a past-president of the Institution of Electrical Engineers and of the Physical Society of London. Professor Perry was noted for his radicalism in practicing and demanding the application of direct teaching, especially in physical science and mathematics. Some of the books of which he was author are "The Steam Engine," "Practical Mechanics," "Spinning Tops," "Cantor Lectures," "Hydraulics," "Calculus," "Applied Mechanics," "Steam," "Practical Mathematics," and "England's Neglect of Science."

JOHN GEORGE LEYNER, of Denver, was killed in an automobile accident near that city, Aug. 5. Mr. Leyner was a pioneer in rock drilling and mining appliances. Through his inventions the rock drill passed from the percussive stage, involving machinery of heavy weights, to the hammer stage, where the rock drill has become a thing but little larger than a pneumatic tool. In 1902 he incorporated the Leyner Engineering Works and built shops at Littleton, Col. His patents and inventions were taken over, in 1911, by the Ingersoll-Rand Co., the works transferred to Phillipsburg, and the Leyner-Ingersoll type of drill was from that time a standard. Mr. Leyner's other inventions include the drill sharpener, now widely used throughout the world. It has been estimated that this sharpener is used for sharpening about 90 per cent of all the machine-sharpened steel in the world. He also invented the "Little Tugger" hoist used in mines and ship yards. He built the original machines used for producing shredded wheat, and his latest invention was the "Linapede" or Leyner farm tractor, on which he was engaged at the time of his death. Mr. Leyner was born in Boulder County, Col., in 1860.

BUSINESS NOTES

JULIUS JANES, formerly president of the Standard Steel Castings Co., Cleveland, has recently concluded an arrangement with the Farrell-Cheek Steel Foundry Co., Sandusky, Ohio, by which he will be the sales representative of that organization in Cleveland and Cuyahoga County, Ohio.

DOW & SMITH, chemical engineers and paving consultants, New York City, announce the opening of a branch office at Columbia, S. C., in charge of T. Keith Legaré, district engineer. Mr. Legaré was formerly connected with the city engineering department of Columbia for 11 years.

A. B. WAY, recently secretary and general manager of the Bridgeport Chain Co., has become affiliated with the Chain Products Co., Cleveland, as district sales manager for New England, with headquarters at the company's New York office.